The Journal of Parasitology

Volume 25 DECEMBER, 1939 Number 6

CHANGES IN THE CONCENTRATION OF UREASE DURING PUPAL DEVELOPMENT OF THE BLOWFLY *PHORMIA REGINA*[1]

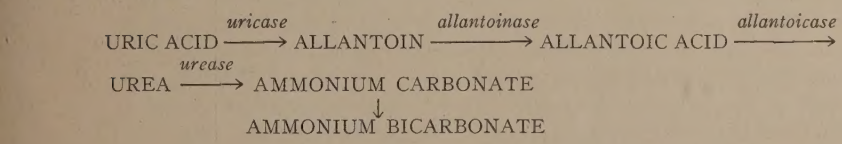
W. Robinson and C. S. Wilson

The enzyme urease has been found in a great variety of organisms. It was first discovered in bacteria and fungi, and later in all types of green plants. Further search has shown that urease occurs also in the tissues of animals, both invertebrate and vertebrate. In addition there is the peculiar fact that it can attack only one substance, namely, urea.

On Urease Activity in Living Tissues

The chief use for this enzyme is in the determination of urea, which it breaks down to ammonium carbonate. A frequent comment upon the occurrence of urease in animal tissues has been that it appears to be of no physiological importance. A complex protein substance such as urease, however, rarely occurs in living organisms from bacteria to man without having some function to perform. Especially does this seem to apply to urease because of its specificity for urea, a common metabolic product of plants as well as of animals.

From the recent work of Brunel and Échevin (1937) in France, there is an indication that urease might play some sort of role in the physiology of plants. These workers studied the presence of four enzymes in a chain concerned with the splitting of uric acid down to ammonium carbonate. The chain is as follows:



They used the seeds of *Agrostemma githago* and noted especially the activity of urease before and after sprouting. They found that in the

Received for publication, April 24, 1939.

[1] Contribution from the Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

dry seeds urease was absent, whereas during germination it was elaborated in considerable quantity. Each of the enzymes in this chain has also been found by a few investigators in some insects. Granick (1937) also discussed the concentration of urease at the time of cellular multiplication. He found that in the soybean this concentration is greatest when the cells of the young plant are rapidly dividing, and that it decreases as the tissues grow older.

Pupae Most Suitable for This Study

The presence of urease in blowfly maggots, noted by Robinson and Baker (1939), has led the way to a study of urease activity during a crucial stage in the development of the blowfly. This is the stage in which pupation occurs, and it is a particularly desirable period for study because radical changes take place without any appreciable variation in weight. *Phormia regina,* recently used surgically in the treatment of nonhealing wounds, was the species used. There is no feeding during pupation, and from outward appearances the insect is dormant. While in the pupal stage, however, an extraordinary change takes place: the headless, legless maggot, with its scavenger habits, develops into the winged adult.

The pupae were obtained from maggots that had been allowed to feed and grow under normal conditions, and the use of artificial, sterilized foods was avoided throughout the tests. The maggots were fed raw beef and allowed to migrate to clean sand for pupation. The nutrients utilized during the pupal period are those stored up during larval feeding, and it was desired that this should be as near normal as possible. Previous work by Robinson and Baker (1939) has shown that these larvae are able to elaborate the enzyme urease within their own tissues, independently of any microorganisms in the food.

On the Method of Making the Determinations

The apparatus and technique used in the determinations of urease by Robinson and Baker was modified somewhat for the present requirements. They had used 10 individuals to make up the required amount of material. This was undesirable in the present investigation as it obscured individual variations. Accordingly, one of us (C.S.W.) modified the standard Van Slyke and Cullen apparatus into a semimicro set-up suitable for individual pupae weighing about 50 mg each. The outfit at the same time was constructed in two sets totaling 24 tubes, which allowed 12 determinations to be made simultaneously.

The method of incubation also had to be modified somewhat. This is the period during which the enzyme urease reacts upon the substrate urea. The standard method is to add urea to the test material, place them in an incubator at about 36° C for the required time, and then to

aerate and titrate with N/50 HCl. One of us (C.S.W.) found that when urea is added to freshly macerated blowfly tissue a set of conditions in the material prevents urease from reacting upon the urea for about 2 hours. Ordinarily, in non-cellular material the enzyme attacks urea at once. The method eventually used was to macerate the pupal tissues in 3 cc of standard buffer solution and leave them for 20 hours to cytolyze under a toluene bacteriostat. The substrate urea was then added, and the material was incubated for an additional 4 hours before the tests were made.

The pupae were taken at various intervals during the pupal period, from 4 hours after entering the pupal stage to 123 hours, which is close to the time of emergence as adults, and classified into six age groups as shown in Table 1. The ages given are average values with not more

TABLE 1.—*Concentration of urease in individual pupae of* Phormia regina *at various ages*

Age of pupae	N/50 HCl neutralized		
	Urea added	No urea added	Difference
hours	*cc*	*cc*	*cc*
4	4.66 ± .18	0.28 ± .02	4.38 ± .18
30	4.28 ± .15	0.23 ± .02	4.05 ± .15
54	6.74 ± .18	0.37 ± .01	6.37 ± .18
80	3.76 ± .26	0.31 ± .01	3.45 ± .26
96	4.79 ± .25	0.33 ± .01	4.46 ± .25
123	4.81 ± .13	0.35 ± .02	4.46 ± .13

than one-half hour variation in the early ages and a little less than 8 hours toward the end. Each age group represents the average of determinations on 16 pupae incubated with urea and on 8 pupae incubated without urea (checks). The difference between the values when urea was added and when urea was not added gives the concentration of urease.

RESULTS

The results for each age group are shown in Table 1, and the urease concentration of the individual pupae is plotted in Fig. 1. A considerable range in values occurs within each age limit, but every test was made on a single pupa, and in general individual variations are not unusual.

Among the points to be noted in the results are the rise and fall in the concentration of urease between the pupal ages of 30 and 80 hours. In that interval the concentration goes up 57 per cent with the peak at 54 hours, and this is followed by a still greater decline. Since these changes are, respectively, 10 and 9 times their probable errors, they may be judged statistically significant. They were not due to changes in weight during the pupal period, because the weight did not vary enough to be significant. The results if plotted as urease per unit weight would give a practically identical curve.

The curve in Fig. 1 fluctuates up and down throughout the period.

At 124 hours the values begin to fall off tremendously, as indicated by the broken line. This is the time when pupation is completed; tissue changes are over and the adults are ready to emerge after 124 hours. Not shown in the present chart are the values because they might be considered as belonging to the adult stage. They also represent such drastic variations that they are left for a separate presentation. Emphasis has at present been placed upon the fluctuations occurring in the pupal stage.

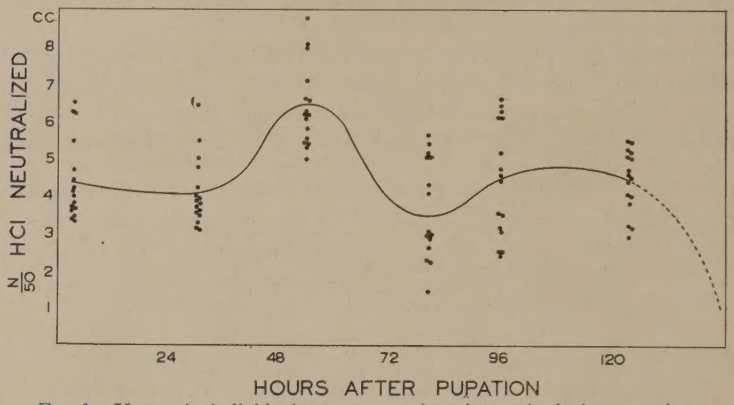


FIG. 1. Urease in individual pupae at various intervals during pupation.

DISCUSSION

During this period in the life of the insect radical changes are taking place both in its anatomy and in its physiology. The larval tissues are broken down and adult organs are built up. Preparation is also being made for an entirely different set of habits. This goes on, of course, without any nutrients entering from the outside and is at the expense of existing material. It is a period of intense enzymic activity, and the enzyme urease appears to participate.

This transformation from the maggot to the fly is remarkable also for the economy with which it is performed. Macalister (1912) and Rose (1921) both suggested that in animals the products of the breakdown of old cells might possibly be re-utilized in the construction of new ones. Here in insects is a concrete example of the development of new cells from old. Urea is a common waste product of metabolism that is of particular interest in a discussion of the activity of urease, because it is the only material that this enzyme can attack. The urea present during pupation becomes the specific substrate for urease.

Ammonium carbonate is the product of the activity of urease. It is rich in nitrogen and is used abundantly by plants as a nutrient. Recent investigations indicate that animal tissues can also utilize ammonia to build up amino acids, which are necessary in the growth of the cell.

Euler, Adler, Gunther, and Das (1938) have shown that bullock and hog-liver preparations can synthesize the important glutamic acid from the a-keto acid and ammonia. Rittenberg, Schoenheimer, and Keston (1939) have recently demonstrated that rat tissues can synthesize, not only glutamic acid, but also arginine, glycine, and aspartic acid. These investigators fed ammonia in a stock diet to the rats and were able to trace the ammonia because it was made up with isotopic nitrogen.

The economy necessary in pupation, together with the curious activity of urease and the production of the nutrient ammonium carbonate, indicates that the pupal tissues of *Phormia regina* can also utilize this ammonium compound. In addition, one of us (W.R.),[2] with the aid of a number of physicians and surgeons, has found that ammonium carbonate and the more stable ammonium bicarbonate actually do stimulate healing, with growth of granulation tissue, in chronic non-healing wounds of domestic animals and man.

Summary

The concentration of the enzyme urease was determined at various intervals during pupal development of the blowfly *Phormia regina*. The pupal stage is particularly suitable for this study, as drastic changes in the anatomy and physiology take place with no appreciable fluctuations in weight. The concentration of urease was found to increase rapidly about 57 per cent toward the middle of the pupal period and to fall off again still more abruptly. Changes occurred throughout the whole period. Especial comment is made on the peculiar specificity of this enzyme for the metabolic waste product urea. The strict economy in the use of nutrients which is necessary during pupation is discussed, along with the possible re-utilization of ammonium carbonate, a breakdown product of this enzyme upon urea.

Bibliography

Brunel, A. and Échevin, R. 1937 Evolution de l'azote, apparition de l'allantoinase et de l'uréase dans les germinations de Nielle (*Agrostemma githago* L.). Compt. Rend. Acad. Sc. **205**: 81–83.

Euler, H., Adler, E., Gunther, G. and Das, N. B. 1938 Über den enzymatischen Abbau und Aufbau der Glutaminsäure. II. In tierischen Geweben. Hoppe-Seyler's Z. Physiol. Chem. **254**: 61–103.

Granick, S. 1937 Urease distribution in *Canavalia ensiformis*. Plant Physiol. **12**: 601–623.

Macalister, C. J. 1912 A new cell proliferant: its clinical application in the treatment of ulcers. Brit. Med. J. **1**: 10–12.

Rittenberg, D., Schoenheimer, R. and Keston, A. S. 1939 Studies in protein metabolism. IX: The utilization of ammonia by normal rats on a stock diet. J. Biol. Chem. **128**: 603–607.

Robinson, W. and Baker, F. C. 1939 The enzyme urease and the occurrence of ammonia in maggot-infected wounds. J. Parasitol. **25**: 149–155.

Rose, W. C. 1921 The influence of food ingestion upon endogenous purine metabolism. II. J. Biol. Chem. **48**: 575–590.

[2] An article describing this work is in the course of publication. (1940, Am. J. Surg.)

THE LIFE HISTORY OF *PLAGIOPORUS LEPOMIS*, A NEW TREMATODE FROM FISHES[1]

CHARLES G. DOBROVOLNY

A new species of trematode of the genus *Plagioporus* infects many game fishes in the upper Huron River system near Ann Arbor, Michigan. A preliminary note on the life cycle of this trematode appeared in an abstract by Dobrovolny (1938). Revisions of the classification of some related species are proposed.

Plagioporus lepomis n. sp.

ADULT

(Figs. 1, 2 and 3)

Specific diagnosis: Plagioporus, small worms, white to light brown in life, active. General outline of body linear-lanceolate. Cuticula smooth, devoid of spines. Acetabulum larger than oral sucker, in anterior third of body. Mouth subterminal, prepharynx short, pharynx globular, esophagus short. Intestinal crura long, terminating near excretory pore. Excretory vesicle saclike, extending forward to level of posterior testis. Excretory pore terminal. Flame cell formula $2[(2+2)+(2+2)]$. Genital pore ventral, to left of median line, between pharynx and intestinal bifurcation. Cirrus pouch curved, extends obliquely from genital pore to anterior part of acetabulum. Vesicula seminalis divided into two parts by narrow, sigmoid constriction. Ejaculatory duct sinuous, thick-walled, pars prostatica poorly developed. Testes two, tandem or slightly oblique, in posterior third of body. Ovary usually orbiculate, anterior to first testis. Oviduct makes two or more complete loops between ovary and seminal receptacle, then joins common vitelline duct and continues anteriorly to meet oötype. Mehlis' gland median, not well defined. Uterine coils few, between testes and acetabulum. Receptaculum seminalis dorsad, usually anteriad to ovary. Vitellaria diffuse, covering most of postacetabular region. Vitelline ducts from follicles join to form common vitelline reservoir ventral to ovary. Laurer's canal ciliated, opening on left margin, slightly anterior to ovary. Uterine eggs few, undeveloped, large. Metacercaria in *Hyalella knickerbockeri.* Cercaria in sporocysts in *Goniobasis livescens.*

Measurements of ten mature worms from different specimens of fish, fixed in Bouin's fluid and mounted in balsam:[2] Length 0.73–1.85, average 1.35. Width 0.28–0.49, average 0.37. Average thickness 0.20. Oral sucker: length 0.09–0.16, average 0.12; width 0.10–0.15, average 0.12. Acetabulum: length 0.18–0.25, average 0.21; width 0.18–0.25, average 0.21. Prepharynx: length 0.003–0.026, average 0.009. Pharynx: length 0.04–0.08, average 0.06; width 0.04–0.08, average 0.06. Esophagus: length 0.04–0.15, average 0.08. Anterior testis: length 0.07–0.20, average 0.15; width 0.11–0.25, average 0.18. Posterior testis: length 0.10–0.24, average 0.17; width 0.12–0.23, average 0.19. Cirrus pouch: length 0.15–0.25, average 0.20; widest width 0.04–0.08, average 0.06. Ovary: length 0.06–0.18, average 0.11; width 0.08–0.19, average 0.13. Receptaculum seminalis: length 0.04–0.10, average 0.07; width 0.04–0.12, average 0.07. Metraterm: length 0.22–0.45, average 0.31; width 0.01–0.04, average 0.03. Uterine eggs: length 0.07–0.08, average 0.079;

Received for publication, May 16, 1939.

[1] Contribution from the Department of Zoology, University of Michigan. Grateful acknowledgment is made to Dr. George R. La Rue for criticisms and helpful suggestions.

[2] All measurements in millimeters.

width 0.04–0.06, average 0.05. Excretory vesicle: length 0.15–0.31, average 0.20; width 0.07–0.10, average 0.09.

Host: Lepomis megalotis peltastes and other centrarchids.
Location: Intestine.
Locality: Huron River, Michigan.
Cotypes: U. S. Nat. Mus., Helm. Coll. No. 9264.

Mueller (1934) emended the genus *Plagioporus* Stafford (1904) in order to include the species *Plagioporus sinitsini sinitsini.*[3] For a discussion of this genus Mueller's description should be consulted. Mueller (1934) defined the genus *Plagioporus* as "The freshwater ALLOCREADIINAE in which the genital pore lies on the level and to the left of the cecal bifurcation, with the cirrus sac lying either entirely, or for most of its length, anterior to the acetabulum. Vitellaria lateral, reaching to posterior end. Parts of cirrus sac in linear arrangement with little or no coiling. Uterus limited to space between ovary and acetabulum."

P. sinitsini huroni has all the characters of the genus except that parts of the cirrus are coiled forming a complete loop. *P. lepomis* likewise has all the characters of the genus except that the parts of the cirrus sac are not in linear arrangement and are coiled. The cirrus sac of *Allocreadium angusticolle* Hausmann (1896; 1897) extends toward the posterior margin of the acetabulum but otherwise appears to have all the characteristics of the genus *Plagioporus.* Therefore this worm is transferred from the genus *Allocreadium* to the genus *Plagioporus,* Stafford (1904). The new combination is then *Plagioporus angusticolle* (Hausmann 1896). *P. angusticolle* likewise develops from a cotylocercaria.

In order to accommodate the above species in the genus *Plagioporus* Mueller's definition is emended as follows:

Genus *Plagioporus* Stafford (1904) char. emend.

Definition: Fresh water ALLOCREADIINAE with genital pore at level and to left of cecal bifurcation, with cirrus sac either entirely, or for most of its length, anterior to acetabulum. Vitellaria lateral reaching to posterior end and may extend forward to oral sucker. Parts of cirrus sac usually in linear arrangement. Uterus limited to space between anterior testis and acetabulum. Eggs relatively large and few. Cercariae stumpy tailed and cotylocercous.

P. lepomis differs from most species of *Plagioporus* by the divided vesicula seminalis and the hosts involved in its life history. *P. sinitsini sinitsini* and *P. sinitsini huroni* are found in the gall bladders rather than in the intestines of fishes. They also differ from *P. lepomis* in the extent of the vitellaria and the size and position of the acetabulum. *P. lepomis* can readily be distinguished from *P. virens* Sinitsin (1931) and *P. sili-*

[3] Since *Plagioporus sinitsini* from Oneida Lake shows anatomical variations from the Michigan species it is desirable to distinguish them by adding subspecific names to each. I propose the name *Plagioporus sinitsini sinitsini* for *Plagioporus sinitsini* Mueller (1934) and the name *Plagioporus sinitsini huroni* for *Plagioporus sinitsini* Dobrovolny (1939).

culus Sinitsin (1931) by the size of the worms, position of the cirrus sac, and the extent of the excretory bladder and vitellaria. In *P. angusticolle* the vitellaria are in the postesophageal region and as already stated the cirrus sac reaches to the postacetabular region.

Comment should be made on an unusual trematode structure, an albumin gland, which Sinitsin (1931) reported from the species of *Plagioporus* from Oregon. Regarding this gland Sinitsin stated "In front of the ovary there is the albumin gland, which appears as a tangled system of tubules." Careful examination of his type specimens of *P. virens* and *P. siliculus* failed to reveal such a structure. Instead they show conclusively that the "tangled system of tubules" can readily be resolved into the coiled portion of the oviducts immediately anterior to the ovaries. Since his slides clearly portray the internal structures of the worms it is evident that Sinitsin failed to determine the true relationship of the female reproductive organs. The female reproductive organs, especially the coiled oviducts, of his species very closely resemble those of *P. lepomis* (Fig. 3).

Plagioporus fusiformis Price (1934) from the eel, *Xenomystax,* appears to be the first trematode of this genus to be described from a marine fish. Price justifiably considered the species of the genus *Lebouria* Nicoll (1909) congeneric with the type species of *Plagioporus* Stafford (1904) and transferred the species from *Lebouria* to *Plagioporus.* Life history studies will no doubt result in radical reclassifications of many species of the ALLOCREADIIDAE. The following key deals with trematodes of the genus *Plagioporus* whose cercariae definitely belong to the cotylocercous group.

Key to Fresh Water Species of *Plagioporus*

1. Vitellaria anterior to acetabulum 2
   Vitellaria posterior to acetabulum 5
2. Cirrus sac not extending to posterior level of acetabulum 3
   Cirrus sac extending to posterior level of acetabulum
   P. angusticolle (Hausmann 1896)
3. Acetabulum near center of body 4
   Acetabulum in anterior third of body; cirrus sac anterior to acetabulum ..... *P. siliculus* Sinitsin (1931)
4. Cirrus sinuous forming a single loop
   P. sinitsini huroni Dobrovolny (1939)
   Cirrus straight without loop .... *P. sinitsini sinitsini* (Mueller 1934)
5. Excretory bladder extending forward to posterior testis; cirrus sac extending to anterior margin of acetabulum
   P. lepomis Dobrovolny (1939)
   Excretory bladder extending forward past anterior testis; cirrus sac wholly anterior to acetabulum ..... *P. virens* Sinitsin (1931)

LIFE HISTORY

The sporocysts and daughter sporocysts of *Plagioporus lepomis* occur in the snail, *Goniobasis livescens* Menke. According to malacologists of the University of Michigan Museum the daughter sporocysts are located in the rectum of the snail. After developing the mature cercariae leave the daughter sporocyst by way of the birth pore and emerge from the snail. They usually attach by their tails and wave back and forth in the manner described by Stunkard (1932). In fresh cool water the cercariae may live and remain infective for several days. Without discrimination these larvae, as *C. dioctorenalis,* will often attach themselves to any organism with which they come in contact. The second intermediate host, which is usually the amphipod, *Hyalella knickerbockeri,* becomes infected through haphazard bodily contact with the cercaria. The cercariae select the softer parts of the integument for penetration and encyst in the abdominal or thoracic regions. Mature metacercariae become infective in seven to fourteen days. The definitive host becomes infected by ingesting the parasitized second intermediate host. Worms with eggs were recovered on the 19th day from fish experimentally infected with metacercariae. In nature large and small specimens of different species of centrarchids are infected.

THE CERCARIA

Only 1.25 per cent of the 43,189 snails, *Goniobasis livescens,* collected from the Huron River above Ann Arbor were infected with cercariae of *P. lepomis.* A paper dealing with the seasonal emergence of the cercaria of *P. lepomis* and other cotylocercous cercariae during 1936 and 1937 is in press. A discussion of the development of the excretory system of cotylocercous cercariae appeared in another paper (Dobrovolny, 1939).

The daughter sporocysts of *P. lepomis* contain about 24 mature cercariae. The saclike sporocysts average smaller than those of *P. sinitsini huroni* ranging from 0.92 to 2.5, average 1.2 mm. in length. Pigment of the living sporocysts may vary in color from chrome yellow to mandarin orange. Six flame cells are present on each of the two independent excretory systems.

The cercaria of *P. lepomis* has the same general behavior and characteristics as all cotylocercariae. Fully distended the cylindrical body may measure over 0.6 mm in length while contracted it is more or less ovate. A partially contracted living cercaria measures about 0.35 mm in length and 0.14 mm in width.

Measurements of ten cercariae, fixed in Bouin's fluid shortly after their emergence and mounted in glycerine, were as follows:[2] Body: length 0.31–0.54, average 0.40; width 0.09–0.14, average 0.12. Tail: length 0.07–0.09, average 0.08; width 0.06–0.08, average 0.07. Oral sucker: length 0.07–0.08, average 0.07; width 0.06–0.07, average 0.06. Acetabulum: length 0.066–0.074, average 0.071; width 0.066–

0.075, average 0.072. Prepharynx: length 0.02–0.04, average 0.03; width 0.03–0.04, average 0.03. Stylet: length 0.015–0.017, average 0.016; width 0.005–0.007, average 0.006. Distended excretory bladder: length 0.11–0.17, average 0.13; width 0.07–0.08, average 0.07.

The cercaria of *P. lepomis* (Fig. 7) in general resembles *C. dioctorenalis* Dobrovolny (1939) and *C. trichocephala* Cable (1939). The body is long and the cup-shaped tail contains long glandular cells whose ducts open to the exterior on the distal margin. The cuticula appears to be aspinose. Two circles of papillae (Fig. 6), each equipped with a sensory hair, surround the muscular lips of the oral sucker. Rows of spines (Fig. 8) encircling the orifice and a simple stylet constitute the armature of the oral sucker. The acetabulum is slightly larger than the oral sucker, armed with spines and provided with six papillae on the inner margin of its lips. The digestive system (Fig. 7) consists of a subterminal mouth, a long prepharynx, a globular pharynx, an esophagus and cells of the developing intestinal crura. The central ganglionic mass is located anterior to the pharynx and dorsal to the esophagus. There are not more than five pairs of penetration glands whose ducts open to the exterior near the stylet. The contents of the thick-walled excretory bladder are discharged to the exterior through two dorsal pores at the base of the tail. The flame cell formula is $2[(2+2)+(2+2)]$. In the cercaria of *P. lepomis* primordia of most of the reproductive organs (Fig. 7) are already clearly differentiated. The testes are median and ventral to the excretory vesicle. From the embryonic testes the vasa efferentia extend forward to unite with the vas deferens at the base of the cirrus pouch. Discernible organs of the female system are the fundaments of the ovary, metraterm, and vitelline ducts but the oviducts, uterus, and seminal receptacle have not become well differentiated from the central cell mass. The development of the reproductive system closely parallels that of *C. dioctorenalis* Dobrovolny (1939).

DISCUSSION

Although *Cercaria trichocephala* Cable (1939) and the cercaria of *P. lepomis* resemble each other they differ in size, number of penetration glands and in the size of stylets. Not until the life cycles of both cercariae have been determined will it be known whether these are distinct species or variations of the same species. The cercaria of *P. lepomis* is distinguished from all the known Huron River species by its long prepharynx. However, a species of cotylocercous cercariae from northern Michigan which appears to be morphologically identical to the cercaria of *P. lepomis* failed to infect the same intermediate hosts. Possibly this difference is entirely physiological.

Under laboratory conditions the cercariae of *P. lepomis* will penetrate and encyst in a wide variety of invertebrate hosts. In nature the most

common second intermediate host is *Hyalella knickerbockeri* which is found in great abundance in the same habitat with the snail. Large numbers of these cercariae will penetrate and encyst in many species of CHIRONOMIDAE. Numerous unsuccessful transmission experiments were conducted with infected chironomids. A study of the metacercariae disclosed that little growth or development occurred in the chironomids and two or three weeks after infection all traces of the parasites are lost. On the contrary the worms grow and develop to the infective stage in larvae of *Hydroporus* sp. They also penetrated but did not develop in simuliid larvae, ostracods and *Daphnia*. The cercaria of *P. angusticolle* Mathias (1936; 1937), a member of the cotylocercous group employs *Gammarus pulex* as its second intermediate host. All attempts to infect the local species of *Gammarus* and amphipods other than *Hyalella* gave negative results.

It has long been evident that the microcercous cercariae do not form a natural group. Cable (1938) divided the microcercous cercariae into various subgroups. He created a cotylomicrocercous group to include the cotylocercous cercariae. Because of its priority and frequent appearance in the literature the word cotylocercous may be preferable to the new term cotylomicrocercous. However, his classification is probably as satisfactory as any that can be made with our present knowledge of the life cycles and phylogeny of these trematodes.

THE METACERCARIA

The metacercariae are harbored in the cavities of the thorax and abdomen of *Hylella knickerbockeri*.

Measurements of the metacercariae are as follows:[2] Cysts: length 0.17–0.21, average 0.19; width 0.13–0.16, average 0.15. Metacercariae: length 0.45–0.46, average 0.45; width 0.14–0.17, average 0.15. Acetabulum: length 0.09–0.11, average 0.10. Oral sucker: length 0.066–0.070, average 0.068; width 0.066–0.074, average 0.072. Pharynx: average width 0.03.

The cyst (Fig. 5) is oval, transparent and thin-walled. The metacercaria doubles up on itself, occupying all the space within the cyst. Excysted infective worms (Fig. 10) are ovate or spatulate in outline. In comparison with the cercariae they show a general increase in size and development. The acetabulum is much longer than the oral sucker and it has six large papillae on the inner margin of the muscular lips. Marked changes in the digestive system are a shortening of the prepharynx and an increase in the size of the intestinal ceca. All traces of the spines and stylet of the cercaria disappear about the third day after encystment. A study of the reproductive system (Figs. 10 and 11) reveals a clearer definition of the outlines of the ducts, marked growth of the testes and the development of the immature ovary from an ovarian

fundament. Eight pairs of flame cells are present and the large cells lining the excretory bladder have lost much of their granular appearance. In the partially contracted worms each of the large glandular cells projects into the lumen of the excretory vesicle (Fig. 5).

To determine the different definitive hosts infective metacercariae were fed to a large variety of experimental fishes. They excyst and maintain themselves for several days in the guppy, *Lebistes reticulatus*. Infection experiments with local species of CYPRINIDAE, PERCIDAE and CATOSTOMIDAE proved negative. In experiments they developed to sexual maturity in most of the local centrarchid fishes as *Lepomis megalotis peltastes, L. gibbosus* and *L. macrochirus*.

SUMMARY

1. The life cycle of *Plagioporus lepomis* was demonstrated experimentally from the cercaria to the adult.

2. Cercariae develop in daughter sporocysts in the snail, *Goniobasis livescens*.

3. Cercariae emerge from the snail and penetrate and encyst in the second intermediate host, *Hyalella knickerbockeri*.

4. Fish which serve as definitive hosts become infected by devouring amphipods containing infective metacercariae.

BIBLIOGRAPHY

CABLE, R. M. 1938 Studies on larval trematodes from Kentucky with a summary of known related species. Am. Midland Naturalist **19**: 440–464.

———1939 Two species of cotylomicrocercous cercariae from Indiana. Tr. Am. Micr. Soc. **58**: 62–66.

DOBROVOLNY, C. G. 1938 Embryology and life histories of some trematodes of the genus *Plagioporus*. J. Parasitol. **24** (Dec. Suppl.): 24. (Abstract.)

———1939 Life history of *Plagioporus sinitsini* Mueller and embryology of new cotylocercous cercariae (Trematoda). Tr. Am. Micr. Soc. **58**: 121–155.

HAUSMANN, L. 1896 Ueber Trematoden der Süsswasserfische. Vorlaufige Mitteilung. Centr. Bakt. I Abt. **19**: 389–392.

———1897 Ueber Trematoden des Süsswasserfische. Rev. Suisse Zool. **5**: 1.

MATHIAS, P. 1936 Sur le cycle evolutif d'un trematode digenetique *Allocreadium angusticolle* (Hausmann). Compt. Rend. Soc. Biol. **122**: 1175–1176.

———1937 Cycle evolutif d'un trematode, de la famille des Allocreadiidae Stossich (*Allocreadium angusticolle* Hausmann). Compt. Rend. Acad. Sc. **205**: 626–628.

MUELLER, J. F. 1934 Two new trematodes from Oneida Lake fishes. Tr. Am. Micr. Soc. **53**: 231–236.

NICOLL, W. 1909 Studies on the structure and classification of digenetic trematodes. Quart. J. Micr. Sc. **53**: 391–487.

PRICE, E. W. 1934 New digenetic trematodes from marine fishes. Smithson. Misc. Collect. **91**: 1–8.

SINITSIN, D. 1931 Studien über die Phylogenie der Trematoden. IV. The life histories of *Plagioporus siliculus* and *Plagioporus virens*, with special reference to the origin of Digenea. Z. Wissensch. Zool. **138**: 409–456.

STAFFORD, J. 1904 Trematodes from Canadian fishes. Zool. Anz. **27**: 481–495.

STUNKARD, H. W. 1932 Some larval trematodes from the coast in the region of Roscoff, Finistere. Parasitology **24**: 321–343.

Explanation of Plates

All the figures, except 6 and 11, which are free hand drawings, were made with the aid of a camera lucida.

E	uterine egg
FO	fundament of ovary
LC	Laurer's canal
MG	Mehlis' gland
OV	ovary
OVD	oviduct
SR	seminal receptacle
TA	anterior testis
TP	posterior testis
UT	uterus
VTC	common vitelline duct
VTD	vitelline duct
VTR	vitelline reservoir

Plate I

Plagioporus lepomis

Fig. 1. Adult, dorsal view.
Fig. 2. Cirrus sac, enlarged.
Fig. 3. Female genitalia, ventral view.
Fig. 4. Extrauterine egg, in glycerine under slight cover glass pressure.
Fig. 5. Infective encysted metacercaria from *Hyalella knickerbockeri.*

Plate II

Plagioporus lepomis

Fig. 6. Cercaria, ventral view of oral sucker showing arrangement of papillae.
Fig. 7. Cercaria, dorsal view, showing reproductive system.
Fig. 8. Cercaria, ventral view, showing excretory system and penetration glands.
Fig. 9. Stylet of cercaria; length, 0.014 mm.
Fig. 10. Infective metacercaria, ventral view.
Fig. 11. Diagram of female genitalia of a recently excysted metacercaria.

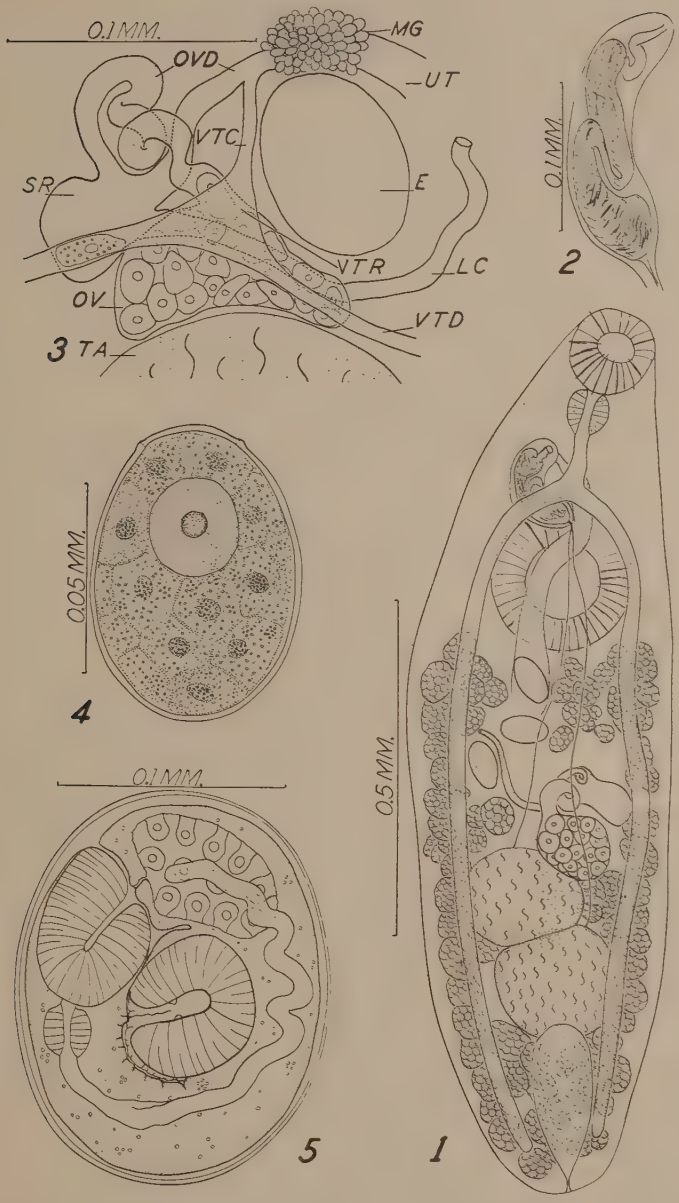

0.1 MM.
OVD
MG
UT
VTC
SR
E
VTR
LC
OV
VTD
3
TA
0.1 MM.
2
0.05 MM.
4
0.1 MM.
5
0.5 MM.
1

PLATE I

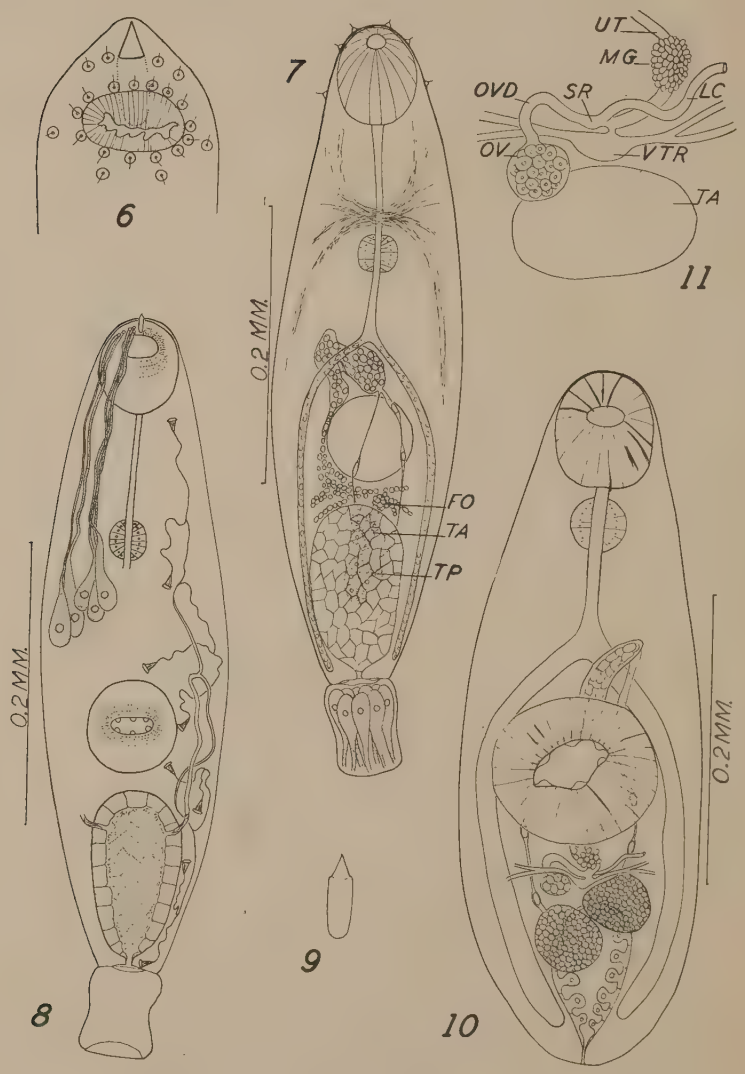


PLATE II

LEPTOPHYLLUM OVALIS N. SP., A TREMATODE FROM THE BROWN WATERSNAKE

ELON E. BYRD[1] AND ROBERT L. ROUDABUSH[2]

During the fall of 1936 one of us (R. L. R.) recovered 25 specimens of a fluke belonging to the genus *Leptophyllum* Cohn 1902. The specimens were removed from the upper small intestine of the brown watersnake, *Natrix taxispilota* (Holbrook), that had been purchased from the Florida Reptile Institute, Silver Springs, Florida, and shipped to Iowa State College about 6 months prior to being examined for its parasites. Due to the fact that the host had been kept in captivity for a period of at least 6 months prior to autopsy, we are unable to state definitely whether we are dealing with a natural infection or an acquired one. All of our specimens had reached full maturity at the time they were removed from their host. This fact may indicate the long standing of the infection, and hence the possibility of its having been shipped to Iowa along with the snake host.

Our material differs from the other two known species of the genus *Leptophyllum* in regards to many details of its anatomy (to be pointed out later) and is described herewith as a new species under the proposed name of *Leptophyllum ovalis*. The description of the species is based on measurements taken from 10 specimens, and will be given as mean measurements with the probable error of the mean. These will be followed by the range of measurements, from least to greatest, set off from the mean by parentheses.

Leptophyllum ovalis n. sp.
(Fig. 1)

Specific diagnosis: Leptophyllum. Body relatively thick, moderately muscular, roughly oval in outline, attaining a maximum width at level of testes, measuring 1.78 ± 0.03 (1.45 to 1.97) mm long by 0.95 ± 0.15 (0.82 to 1.04) mm wide. Cuticula smooth, spines entirely absent. Oral sucker subterminal, muscular, 0.27 ± 0.06 (0.23 to 0.30) mm in diameter. Acetabulum strongly muscular, 0.29 ± 0.06 (0.24 to 0.35) mm long by 0.45 ± 0.05 (0.42 to 0.57) mm wide, lying 0.62 ± 0.13 (0.48 to 0.70) mm behind anterior margin of body, slightly in advance of body middle. Pharynx solid band of muscles lying immediately behind oral sucker, surrounded by gland cells that are more numerous about posterior half, measuring 0.10 ± 0.06 (0.09 to 0.11) mm in diameter. Esophagus short, less than 50 μ in length. Ceca relatively slender tubes with rather prominent epithelium, extending posteriorly to or just beyond caudal boundary of testes. Genital pore to right of midline, just inside right cecum, midway between acetabulum and bifurcation of ceca. Ovary slightly oval in outline, 0.15 ± 0.08 (0.11 to 0.23) mm long by 0.13 ± 0.05 (0.11 to 0.17) mm wide, usually lying close behind left posterior quadrant of acetabulum, occasionally partly dorsal and to left side of acetabulum. Shell gland mesial to ovary. Seminal receptaculum as large as or larger than ovary, usually lying mesial

Received for publication, June 19, 1939.

[1] Zoology Department, University of Georgia.
[2] Ward's Natural Science Establishment, University of Rochester.

and posterior to ovary. Laurer's canal present, terminating blindly under dorsal surface of body posterior to level of ovary. Uterus greatly convoluted, passing to near caudal margin of body, ascending to genital pore, much coiled between right testis and acetabulum. Metraterm pronounced, irregularly sinuous, muscular, with rather heavy cuticular lining and numerous peri-vaginal gland cells, extending forward from about equatorial plane of acetabulum around right side of that sucker to genital pore, opening to outside through a common opening with cirrus. Ova fairly numerous, operculated, 50 to 63 μ long by 25 to 30 μ wide. Vitellaria follicular, lateral and ventral to other organs, from posterior margin of acetabulum to posterior margin of testes, usually with 1 to 5 more follicles on left side than on right. Transverse yolk ducts at anterior margin of testes, uniting to form small but prominent yolk reservoir. Testes opposite, smooth to irregular in

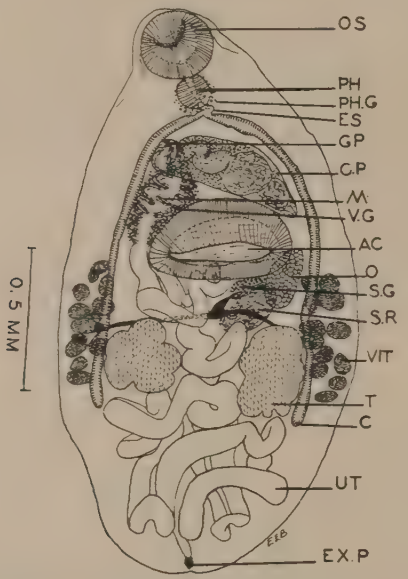


FIG. 1. *Leptophyllum ovalis* n. sp. Entire mount from ventral view, drawn with the aid of the camera lucida. AC = acetabulum; C = cecum; C.P = cirrus pouch; ES = esophagus; EX.P = excretory pore; G.P = genital pore; M = metraterm; O = ovary; OS = oral sucker; PH = pharynx; PH.G = pharyngeal glands; S.G = shell gland; S.R = seminal receptaculum; T = testis; UT = uterus; V.G = vaginal glands; VIT = vitellaria.

outline, often deeply indented, slightly longer than wide, placed close behind level of ovary, often with left testis very slightly overlapping caudal boundary of ovary; right testis slightly smaller than left, measuring 0.28 ± 0.08 (0.23 to 0.35) mm long by 0.20 ± 0.09 (0.13 to 0.30) mm wide for the right and 0.29 ± 0.09 (0.22 to 0.35) mm long by 0.27 ± 0.03 (0.16 to 0.29) mm wide for the left testis. Vasa efferentia uniting at entrance to cirrus sac. Cirrus sac rather large, from 0.56 to 0.65 mm long by 0.18 mm in greatest width, lying almost transversely across body in front of acetabulum, often curving distally to extend around left side of acetabulum to about caudal boundary of that sucker, containing muscular pars prostatica and cirrus, both of which bear spine-like projection on their inner lining, and a much dilated and slightly coiled seminal vesicle; the pars prostatica is surrounded externally by nu-

merous prostatic gland cells. Excretory system not studied; excretory pore dorsal, very slightly in advance of caudal boundary of body, guarded by well developed sphincter muscle; excretory bladder appears to be straight tube ascending forward from pore to about level of ovary.

Host: Natrix taxispilota (Holbrook).

Habitat: Upper small intestine.

Locality: Florida (?) (Iowa), U. S. A.

Type specimen: U. S. Nat. Mus. Helm. Coll. No. 9312. Additional specimen No. 9313.

The genus *Leptophyllum* was established by Cohn (1902) for the reception of *L. stenocotyle,* a new species collected from the rectum and cloaca of the snake *Herpetodryas fuscus* from South America. Recently McIntosh (1939) has added a second species, *L. tamiamiensis*, from the rectum and cloaca of *Agkistrodon piscivorus* from Miami, Florida. The present species is the third member of the genus, and comes from the intestine of a watersnake, *Natrix taxispilota,* from Silver Springs, Florida.

The present species resembles very closely the other two species assigned to the genus in regards to every detail of its anatomy, but differs in regards to both the habitat and host. *Leptophyllum stenocotyle* is described from the rectum of *Herpetodryas fuscus* from South America and *L. tamiamiensis* comes from the uterus and cloaca of *Agkistrodon piscivorus* from Miami, Florida, while the present species is described from the small intestine of the watersnake, *Natrix taxispilota,* from Silver Springs, Florida. Recently one of us (E. E. B.) has been fortunate in obtaining over 1500 specimens of *Leptophyllum tamiamiensis* from the cloaca of the cotton-mouth or water moccasin from Melbourne, Florida, for comparison. These two species differ mainly in the larger size of the body and internal organs of the present species. The length of the body in *L. ovalis* is 1.78 mm and the width is 0.95 mm whereas these measurements for the other two species are scarcely more than 1 mm for the length and 0.5 to 0.6 mm for the width. The greater size of all internal organs is pronounced with one exception: the metraterm in the present species is shorter than the total length of the cirrus sac and is much more muscular than is noted for this organ in *L. tamiamiensis.* The body musculature is much more pronounced in *L. ovalis* than is the case with the species from the water moccasin. In *L. ovalis* the follicles of the vitellaria show a decided tendency to be more numerous on the left side while the ovary is elongated oval rather than round or nearly round.

Bibliography

Cohn, Ludwig. 1902 Zwei neue Distomen. Centr. Bakt. I Abt. Orig. **32**: 877–882.

McIntosh, Allen. 1939 Description of plagiorchioid trematode, *Leptophyllum tamiamiensis* n. sp., from a poisonous snake. Proc. Helm. Soc. Wash. **6**: 92–94.

THE NEMATODE *SKRJABINGYLUS CHITWOODORUM* N. SP. FROM THE SKUNK*

WILLIAM C. HILL

Five skunks—2 specimens of *Mephitis mesomelas mesomelas* and 3 of *Spilogale interrupta*—collected in Oklahoma early in 1939, were all found to be infected in frontal sinus of the skull with from 2 to 50 specimens of an apparently new metastrongylid worm of the genus *Skrjabingylus* Petrow 1927.

The nemas were all fixed in hot 70 percent alcohol, cleared in Magath's glycerolactophenol, and transferred to glycerin for study.

The terms *amphid, deirid, phasmid,* and the names of cephalic papillae, are used as by Chitwood and Wehr (1934).

Skrjabingylus chitwoodorum n. sp.
(Figs. 1–7)

General anatomy: Body bright red (in life), stout, transparent. Cuticle thick, marked by deep, wide-spaced, regularly arranged, annular constrictions. Mouth broadly ovoidal, dorsoventrally elongate, without labia; surrounded by 16 minute papillae which approach, in arrangement, the hypothetical primitive cephalic pattern described by Chitwood and Wehr (1934). Internal circle with 3 pairs of papillae having short "pulps" directed posteroperipherad; external circle with 5 pairs. Amphids, pore-like, dorsal to the ventrolateral papillae and in the positions assigned to the missing dorsolateral papillae in the hypothetical pattern.

Wall of stoma yellowish brown, heavily chitinized; with 3 prominent internal ridges, the median one being dorsal and largest; with both inner and outer surfaces densely covered with minute dentiform and mammilliform protuberances of variable size and appearance. Dorsal internal ridge of stoma extends farthest forward, reaches edge of mouth, and has its front end provided with an anteriorly directed pore-like indentation, not observed in the other ridges. Esophagus long and muscular, slightly enlarged at either end, partially enveloping vestibule in front, and provided posteriorly with a prominent 3-lobed valvular apparatus projecting into intestine. Nerve ring near middle of esophagus. Excretory pore, slightly behind nerve ring, with short duct opening into a pair of large, elongate, subventral, saccate gland cells, having narrow posteriad extensions which lead apparently to the lateral lines. These cells, about 1.25 mm long, usually extend considerably beyond the junction of esophagus and intestine.

Female: Lighter in color and considerably larger than male. Body straight. Measurements taken from 3 gravid, preserved specimens under cover glass pressure; listed in the same order respective to the 3 worms in every case. Length 29, 23, 27 mm. Width near middle of body 660, 585, 510 μ. Length of vestibule from anterior end of body 75, 60, 45 μ; width at widest level in all three 75 μ. From anterior end—excretory pore 405, 450, 435 μ; nerve ring 270, 330, 270 μ;

Received for publication, July 3, 1939.

* A contribution from the Zoological Laboratory of the Oklahoma Agricultural and Mechanical College, prepared under the direction of R. Chester Hughes.

The first specimens of the new species were found and kindly presented to the writer by Professor G. A. Moore of the same institution.

The new species is named in honor of Drs. B. G. and M. B. Chitwood, by whom the important "Introduction to Nematology" is now being published in serial form.

back end of esophagus 990, 1035, 810 μ; vulva 15, 10.5, 14.5 mm. Width of esophagus near posterior end 98, 105, 90 μ. Vulva heavily muscular, its external opening a transverse slit. Vaginae and uteri divergent: Uteri coiled about intestine. Opposed ovaries loosely coiled, each about midway between vulva and respective end of body. Vaginae and distal portions of uteri in live specimens filled with active larvae, largest of which measure 455 × 15 μ. Larvae closely resembling those of the new species were recovered from the stomach of one of the infected skunks.

Tail short, about 75 μ long, provided with an unpaired subterminal and a pair of ventrolateral protuberances, slightly anterior to which occur the ventrolateral phasmids.

Male: Darker and considerably smaller than female. Measurements taken from 4 preserved specimens under cover glass pressure. Length 13 to 17 (average 15) mm, width near middle of body 340 to 488 (average 436) μ. From anterior end—nerve ring 236 to 340 (average 292) μ; excretory pore 375 to 493 (average 450) μ; back end of esophagus 695 to 726 (average 710) μ; base of vestibule 29 μ in all 4 specimens. Width of esophagus near posterior end 66 to 74 (average 68) μ. Maximum width of vestibule 52 to 59 (average 57) μ. Male generative tract slightly sinuous, extends forward from cloaca ending near anterior third of body.

Posterior end of body provided with a pair of small, entirely separate (leptoderan), ventrolateral alae each containing 6 pedunculated papillae (rays), of which numbers 1, 2, 4, and 5 (counting from the anterior edge) appear to terminate on the ventral surfaces of the alae while numbers 3 and 6 end on the dorsolateral surfaces. Intercuticular matrix of alae granular. Body between the alae provided with a median precloacal, and 3 pairs of postcloacal sessile papillae. Unpaired papilla, minute, and located immediately in front of anus. First paired papillae, comparatively large, located at posterolateral angles of anus and partly within cloaca. Next 2 pairs very minute, situated close together near tip of tail, second pair being anteromedial to third. Tail ends in a short slender ventroterminal spine-like process.

Spicules similar in size and shape; 540 to 710 (average 631) μ long and 15 to 29 (average 22) μ wide at anterior end; somewhat acicular; each comprised of an inner brownish-yellow medullary region and a thin colorless transparent cortical layer, the latter most noticeable posteriorly and scarcely discernible at the front end; enlarged and adorned anteriorly with variously shaped protuberances; each bearing along almost the entire length two narrow longitudinal alae enclosing a medially directed concavity; each terminating posteriorly in a slender-tipped, leaf-like, dorsoventrally flat, expansion consisting mostly of the cortical substance above-mentioned. Alae of spicules supported by many irregularly shaped rays. Each ala merges imperceptibly into body of spicule near front end and terminates posteriorly in a short free rounded tip slightly anteriad to above-mentioned leaf-like ending of spicule proper. Gubernaculum 72 to 88 (average 80) μ long, tongue-shaped and provided with median ventral longitudinal ridge separating two parallel concavities.

Hosts: Mephitis mesomelas mesomelas Lichtenstein 1832 and *Spilogale interrupta* (Rafinesque 1820).

Habitat: Frontal sinus of skull.

Locality: Blaine and Payne counties, Oklahoma.

Cotype specimens: A vial of several alcoholic specimens in U. S. Nat. Mus. Helm. Coll.

DISCUSSION

The genus *Skrjabingylus* now contains two species *Skrjabingylus nasicola* (Leuckart 1842) Petrow 1927 and the new form. The descriptions of the former used in this study are those of von Linstow (1873) and Cameron (1927), both of whom used the name *Filaroides muste-*

larum (Rudolphi 1819) van Beneden 1858. It was pointed out by Petrow (1928) that the names of two distinct, not closely related, species, originally known as *Spiroptera nasicola* Leuckart 1842 and *Filaria mustelarum pulmonalis* Rudolphi 1819, have been often confused in the literature and that the species described by both von Linstow (1873) and Cameron (1927) as *Filaroides mustelarum* was really the present-day *Skrjabingylus nasicola.*

Skrjabingylus chitwoodorum differs from *Skrjabingylus nasicola* in having (1) a considerably larger size; (2) the spicules actually and relatively longer; (3) an additional pair of pedunculated papillae and (4) seven sessile papillae on the male tail—no sessile papillae having been described for *S. nasicola;* (5) two additional protuberances and a pair of papillae on the female tail; (6) a recognizable pattern of cephalic papillae—none reported for *S. nasicola;* and (7) in having been found in American mustelids.

In a recent revision of the family METASTRONGYLIDAE Leiper 1908, Böhm and Gebauer (1934) place *Skrjabingylus* in their new subfamily BRONCHOSTRONGYLINAE.

BIBLIOGRAPHY

BÖHM, L. K. AND GEBAUER, O. 1934 Zum System der Familie der Metastrongylidae Leiper 1908. Zool. Anz. **105**: 287–294.

CAMERON, T. W. M. 1927 Studies on three new genera and some little-known species of the nematode family Protostrongylidae Leiper, 1926. J. Helm. **5**: 18–23.

CHITWOOD, B. G. AND WEHR, E. E. 1934 The value of cephalic structures as characters in nematode classification, with special reference to the superfamily Spiruroidea. Z. Parasitenk. **7**: 274–335.

VON LINSTOW, O. 1873 Einige neue Nematoden. Arch. Naturg. **39**: 300–304.

PETROW, A. M. 1928 Addition to the explanation of systematics of nematodes parasitic in the frontal sinus and lungs of Mustelidae. Ann. Trop. Med. and Parasitol. **22**: 259–264.

EXPLANATION OF PLATE

All figures concern *Skrjabingylus chitwoodorum* n. sp. and except Fig. 4 were drawn with the aid of a camera lucida.

FIG. 1. Pair of spicules. Scale, 100 μ.

FIG. 2. Optical cross section of body through the vestibule—shows internal ridges and rough inner and outer surfaces of wall of stoma. Scale, 100 μ.

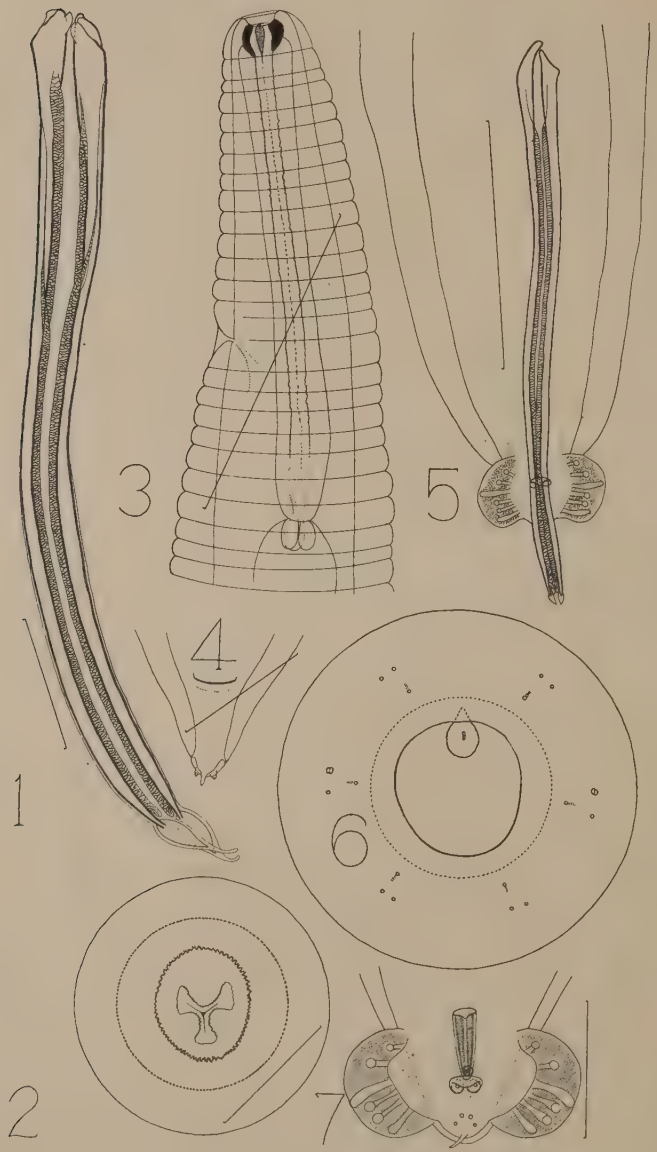
FIG. 3. Anterior end of body, lateral view—shows stoma, excretory pore, esophagus, and esophagointestinal valve. Scale, 1 mm.

FIG. 4. Posterior end of female, ventral view—shows anus, phasmids, and terminal protuberances. Scale, 100 μ.

FIG. 5. Male tail, ventral view—shows bursa, rays, and spicules protruded slightly. Scale, 300 μ.

FIG. 6. En face view—shows mouth, thickness of wall of vestibule, pore-like opening of dorsal ridge in vestibule, amphids, and arrangement of cephalic papillae.

FIG. 7. Male tail, ventral view—shows leptoderan alae with rays, gubernaculum, and arrangement of sessile papillae. Scale, 100 μ.



Skrjabingylus chitwoodorum

OOCHORISTICA WHITENTONI, A NEW ANOPLOCEPHALID CESTODE FROM A LAND TORTOISE[1]

GERALD M. STEELMAN

A land tortoise, *Terrapene triunguis* (Agassiz 1857), taken near Stillwater, Oklahoma, in May 1939, provided 11 specimens of an apparently heretofore undescribed anoplocephalid cestode of the genus *Oochoristica* Lühe 1898. Mr. William C. Hill of Stillwater informs me that in the past year he has examined 11 specimens of *T. triunguis* and 35 of *T. ornata* (Agassiz 1857) for parasites but has encountered no cestodes. The name *Oochoristica whitentoni*[2] is proposed for the new species. The 11 worms were measured alive, fixed in hot "sublimate acetic," and mounted in toto.

Oochoristica whitentoni n. sp.

(Figs. 1–7)

Description: Oochoristica. Length of 11 specimens, measured alive, 12.3 (1.5–27.5) cm. Measurements taken from 10 mounted specimens are as follows: suckers 0.16 (0.15–0.18) mm in diameter; scolex 0.40 (0.36–0.44) mm wide; segmentation begins 3.3 (2.9–3.6) mm behind anterior end of scolex; immature segments 0.26 (0.09–0.39) mm long by 0.57 (0.33–0.73) mm wide; mature segments 0.95 (0.56–1.36) mm long by 1.04 (0.79–1.13) mm wide; cirrus sac 0.19 (0.13–0.23) mm by 0.09 (0.07–0.12) mm; ovary 0.29 (0.13–0.36) mm wide; testes 0.04 (0.02–0.06) mm in diameter. In one complete strobila, measuring 9.5 cm in length when mounted, there are 134 immature and 77 mature proglottids. No gravid segments found on any specimen. Immature segments short, wide; with increasing age segments become progressively relatively longer.

Scolex rounded anteriorly, followed by short neck region which is somewhat narrowed. Beginning of segmentation appears as light transverse lines separating bands of deeper-staining tissue. Genital organs first apparent as an ovoid mass of deeply staining nuclei centrally placed in segment; this mass soon becomes medially elongate with anterior end curved to one side. Genital atrium first appears in mature segments at which time cirrus and cirrus pouch are represented by an undifferentiated mass of cells and do not become separately recognizable until later.

Two lateral excretory canals on each side arise in anterior portion of scolex. In apical portion of scolex each canal terminates in 2 anastomoses which connect it respectively with its contralateral mate and its ipsilateral fellow—the 4 anastomoses, slightly bowed anteriad, constituting, in effect, a 4-merous annular commissure. Dorsal canals much smaller and more sinuous than ventral ones and without visible branches or anastomoses. Ventral canals nearly uniform in diameter and without transverse commissures or visible branches in anterior end of strobila. Proceeding posteriad dilatations gradually appear in ventral canals near posterior border of each segment. Commissures apparently first arise as knob-like outgrowths from these swellings, those on opposite sides growing toward each other until they meet and unite forming a simple transverse canal. Later

Received for publication, July 3, 1939.

[1] A contribution from the Zoological Laboratory, Oklahoma Agricultural and Mechanical College, prepared under the direction of R. Chester Hughes.

[2] The new species is named in honor of Professor R. O. Whitenton, Head of the Department of Zoology in the above-mentioned institution.

islands appear at various points along this canal, and especially in the enlargements at the ends, resulting in a branching and anastomosing effect of increasing complexity. Thus in definitive form the transverse commissure, still single and undivided only in the middle of the segment, is connected with the ventral canals through retia of anastomoses of extremely variable pattern. Additional connecting links, seemingly arise independently in the forward part of the proglottid, as diverticula that grow backward from the ventral canals to join this plexus. Branches of these networks, usually confined to proglottid in which they arise, may occasionally extend into next segment behind. A broad ventral lateral nerve present in each side between ventral excretory canal and margin of worm.

Genital pores marginal, irregularly alternate, located in anterior third of segments. Genital atrium large. Cirrus coiled. Cirrus sac, narrowly ovate, extends to, or just past and between, longitudinal excretory canals. Vas deferens, much convoluted in older segments, extends medially from cirrus to center of proglottid where it turns posteriad passing ventral to transverse median portion of ovary to terminate near level of vitellarium. Vagina runs from postero-median surface of genital atrium behind cirrus sac, thence gently curving posteriad to become obscure just anterior to vitellarium. Ovary median, comprising two lateral lobated wings connected by a transverse median portion. Vitellarium an ovoid mass just posterior to ovary. Mehlis' gland located in median line between ovary and vitellarium. Testes spheroidal, numbering about 100 to 150 in each segment, behind and posterolateral to ovary, disposed in a crescentic band with concavity directed forward, all between lateral excretory canals. No eggs observed.

Host: Terrapene triunguis (Agassiz 1857).

Habitat: Small intestine.

Locality: Stillwater, Oklahoma.

Type: One complete strobila mounted in toto on a microscope slide in U. S. Nat. Mus. Helm. Coll.

DISCUSSION

According to Hughes (1940) the genus *Oochoristica* Lühe 1898 contains 42 previously described species, 27 of which occur as adults in reptiles, 15 in mammals. The reptilian species have thus far been reported only from SAURIA and SERPENTES, the new species being the first to be recorded from TESTUDINATA. *O. whitentoni* is much longer than any other reptilian form, particularly in view of the fact that my longest strobilae are without gravid segments. The only squamatine species having nearly so many testes as the new form is *O. phrynosomatis* (Harwood 1932). *O. whitentoni* differs from *O. phrynosomatis* in having (1) a much longer strobila, (2) a much smaller cirrus pouch, (3) squarish, rather than narrowly elongate, mature proglottids, and (4) a chelonian host.

It is well known that tapeworms are of infrequent occurrence in TESTUDINATA. It would seem that *O. whitentoni* is the only chelonian cestode of the order CYCLOPHYLLIDEA Braun 1900 thus far to be described.

BIBLIOGRAPHY

HARWOOD, P. D. 1932 The helminths parasitic in the Amphibia and Reptilia of Houston, Texas, and vicinity. Proc. U. S. Nat. Mus. **81**: 1–71.

HUGHES, R. C. 1940 The genus *Oochoristica* Lühe 1898. Am. Midland Naturalist **23** (in press).

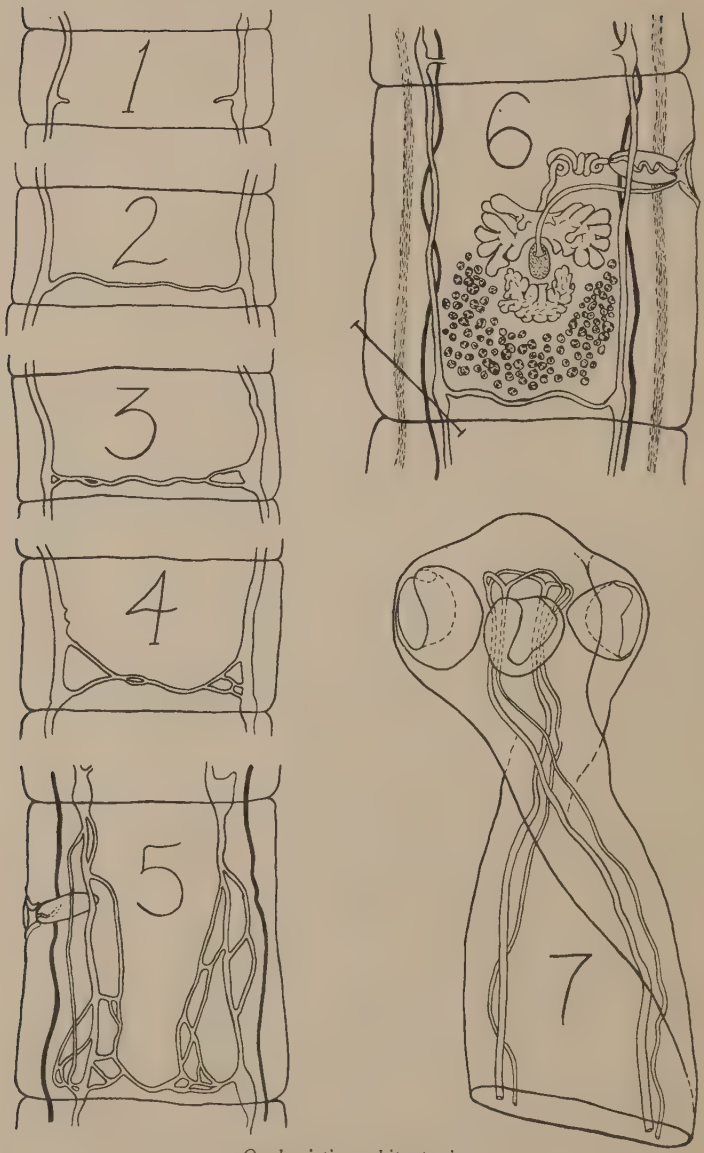
Explanation of Plate

All drawings concern *Oochoristica whitentoni* n. sp. Fig. 6 was drawn with the aid of a camera lucida, the others freehand.

Figs. 1 to 5. A series of successively older proglottids illustrating the development of the transverse ventral excretory canals and associated retia. The last of the series is mature.

Fig. 6. Typical fully mature segment, ventral view. Plexus of excretory vessels omitted. Scale, 0.5 mm.

Fig. 7. Scolex (neck accidentally twisted). Note how the 4 longitudinal excretory canals are connected together by an annular series of anastomoses.



Oochoristica whitentoni

A NEW SPECIES OF *DIORCHIS* (CESTODA: HYMENOLEPIDIDAE) FROM THE CANVASBACK*

L. Helen Long and Nelson E. Wiggins

A freshly killed female canvasback, *Nyroca valisneria* (Wilson 1814), collected in March 1939 near Stillwater, Oklahoma, yielded 45 specimens of an apparently new hymenolepidid tapeworm, for which the name *Diorchis nyrocae* is proposed. Only the one canvasback was examined. The new species was not found in either of two blue-winged teals collected on the same occasion.

Twelve of the living worms, all having gravid proglottids, were straightened out, but not stretched, for gross measurements on a plate of glass. The worms were then all fixed in hot Bouin's fluid. For permanent mounts some of the specimens were stained with borax carmine. Except for length and width of the entire strobila the measurements recorded below were all taken from in toto mounts; in general they indicate the average, minimum, and maximum for several specimens.

Diorchis nyrocae n. sp.
(Figs. 1–5)

General anatomy: Scolex 289–348 μ wide. Rostellum 273 μ long and 100 μ wide; armed with a single row of 10 hooks about 27 μ long; retraction effected by introversion of a zone circumferential to hooks, apex not being invaginated. Suckers, 4; elliptical, longitudinally elongate; 149 μ long and 99 μ wide; armed on anterior three-fourths of margin with a band of 4 or 5 rows of minute quincuncially arranged spines about 6 μ long. Neck very short.

Strobila with over 2000 proglottids; 207 (125–280) mm long by a maximum width of about 1 mm; very thin, slender, flat, delicate, and nearly colorless and transparent in life; segmentation apparent immediately back of scolex; margins serrate except along first millimeter of length. Proglottids extremely short in comparison to width; width-length ratio, one-ninth (one twenty-seventh to one-third); with mature male genitalia at 6–10 mm from scolex; with ovaries, mature at 25–30 mm, and of maximum size at 60–75 mm back of scolex. Genital atria anteromarginal and inconspicuous. Genital ducts dorsal to excretory canals. Cirrus pouches slender, usually straight, and usually extending directly mediad from atria. Lateral nerves near margins. Longitudinal excretory canals ill-defined with delicate walls; general location indicated by paired bands of greater transparency than rest of proglottis, located from one-fourth to one-third width of segment from respective margins; ventral vessels very broad; dorsal vessels (seen in cross sections) much smaller and somewhat medial to ventral ones. About 24 bundles of fibers in the inner layer of longitudinal muscles; bundles smaller and much more numerous in outer layer.

Reproductive systems: Testes—2, spheroidal; maximum diameter often exceeding length of segment, especially in contracted strobilae; those of one pro-

Received for publication, July 3, 1939.

* Contribution from the Zoological Laboratory, Oklahoma Agricultural and Mechanical College, prepared under the direction of R. Chester Hughes.

The writers are indebted to Mr. Richard L. Schultz for having prepared serial sections of the new tapeworm.

glottis often alternate in arrangement with those of next; one (right or left, indifferently) apparently preceding the other both in development and later disappearance; both usually disappear before female organs become fully formed. Cirrus pouch slender, elongate, transversely arranged; reaches inward from atrium to slightly beyond excretory canals; 160 μ long by 21 μ in diameter in segments showing testes of maximum size; its interior almost completely occupied by internal seminal vesicle; walls slightly thickened at both extremities. External seminal vesicle spheroidal; 80 μ in greatest diameter in segments with mature male genitalia. Vasa efferentia not observed.

Ovary median; small, occupying not more than one-third width of proglottis; 3- (rarely 2- or 4-) lobed, with median lobe directed dorsad; lobes smoothly spheroidal to ellipsoidal; 190 to 250 μ wide in mature condition. Vitellarium spheroidal, dorsomedian, and slightly posterior to ovary; 60 to 67 μ in maximum diameter at functional maturity. Mehlis' gland anterior to ovary and vitellarium. Uterus appears first as a narrow transverse band in front of shell gland; later its extremities widen irregularly, sometimes giving it a dumbbell form; fully gravid it occupies most of interior of segment. Vagina of irregular sinuous form; ventral to cirrus pouch and external seminal vesicle; enlarged medially as a seminal receptacle, located dextrad to ovary; thin-walled and especially difficult to trace along its distal half. Fully developed oncospheres narrowly ellipsoidal and enclosed in 2 correspondingly elongate membranous coverings, the outer being finely punctate. Outer membrane 71 by 21 μ. Inner membrane 59 by 18 μ. Embryo 33 by 13 μ.

Host: *Nyroca valisneria* (Wilson 1814).

Habitat: Small intestine.

Locality: Stillwater, Oklahoma.

Cotype specimens: Two entire strobilae mounted in toto, each on a series of microscope slides, and a number of alcoholic specimens, in U. S. Nat. Mus. Helm. Coll.

DISCUSSION

The genus *Diorchis* Clerc 1903 now contains 16 recognized species of tapeworms parasitic as adults in birds representing inter se the orders ANSERIFORMES, GRUIFORMES, and COLUMBIFORMES. The species are *D. acuminata* (Clerc 1902) Clerc 1903, *D. americana* Ransom 1909, *D. bulbodes* Mayhew 1929, *D. crassicollis* Sugimoto 1934, *D. excentricus* Mayhew 1925, *D. flavescens* (Krefft 1871) Johnston 1912, *D. formosensis* Sugimoto 1934, *D. inflata* (Rudolphi 1819) Fuhrmann 1932, *D. jacobii* Fuhrmann 1932, *D. kodonodes* Mayhew 1929, *D. longicirrosa* Meggitt 1927, *D. magnicirrosa* Moghe and Inamdar 1934, *D. microcirrosa* Mayhew 1929, *D. nyrocae* n. sp., *D. spinata* Mayhew 1929, and *D. spiralis* Szpotańska 1931. Besides the new form, the species of Mayhew (1925 and 1929) and Ransom (1909) have been described from North America.

The new species differs from its apparent nearest relative, *Diorchis acuminata*, as described by Clerc (1903), in having (1) a much longer and relatively more narrow strobila, (2) a larger scolex, (3) hooks of shorter average length, (4) much more numerous inner longitudinal muscle bundles, (5) the cirrus pouch more narrowly elongate and more nearly cylindrical, (6) the ovary trilobed rather than double, and (7) the vagina thin-walled and apparently nonmuscular.

Bibliography

Clerc, W. 1903 Contribution à l'étude de la faune helminthologique de l'Oural. Rev. Suisse Zool. **11**: 241–368.

Mayhew, R. L. 1925 Studies on the avian species of the cestode family Hymenolepididae. Illinois Biol. Monogr. **10**: 1–125.

———1929 The genus *Diorchis* with description of four new species from North America. J. Parasitol. **15**: 251–258.

Ransom, B. H. 1909 The taenioid cestodes of North American birds. Bull. U. S. Nat. Mus. **69**: 1–141.

Explanation of Plate

All figures concern *Diorchis nyrocae* n. sp. and were all drawn with the aid of a camera lucida.

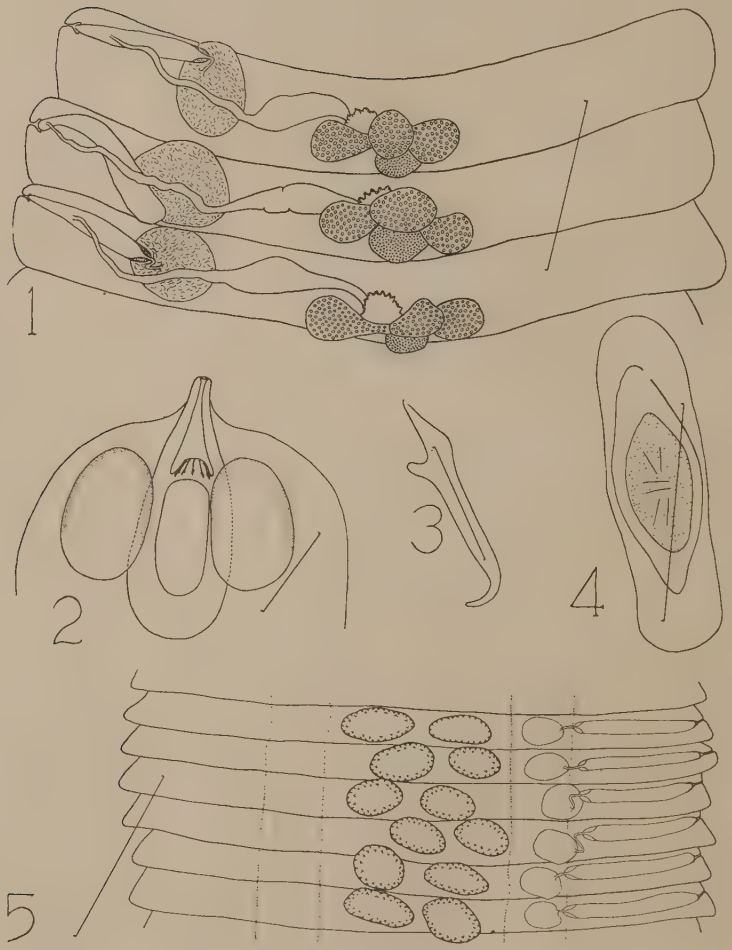
Fig. 1. Proglottids containing mature female reproductive system, ventral view. Note the cirrus pouch, large external seminal vesicle, vagina enlarged medially as a seminal receptacle and not traced laterally to its external orifice, 3-lobed ovary, vitellarium shown in heavy stipples, and Mehlis' gland in crenulate outline. Scale, 200 μ.

Fig. 2. Scolex with rostellum retracted. Scale, 100 μ.

Fig. 3. Rostellar hook. Scale, 15 μ.

Fig. 4. Mature egg. Scale, 50 μ.

Fig. 5. Successive proglottids showing mature male reproductive organs, dorsal view. Scale, 200 μ.



Diorchis nyrocae

A NEW UNARMED TAPEWORM FROM THE SPOTTED SKUNK*

HAROLD J. PEERY

A spotted skunk, *Spilogale interrupta* (Rafinesque 1820), collected near Perkins, Oklahoma, March 10, 1939, was found to harbor 15 specimens of an apparently new anoplocephalid cestode for which the name *Oochoristica oklahomensis* is proposed.

The worms were fixed in acetic-sublimate solution, stained in borax carmine, cleared in toluol, and mounted in balsam. All of the measurements recorded below, except the length of the entire strobila, were taken from preserved specimens.

Oochoristica oklahomensis n. sp.
(Figs. 1–2)

General features: Live strobila, straightened but not stretched, 29–124 mm long and 0.9–1.47 mm wide; one specimen 106 mm long had 195 proglottids. Margins slightly serrate in middle portion of strobila, otherwise nearly smooth. Scolex unarmed, 508–705 μ in diameter. Suckers aspinous, 222–296 μ long by 195–225 μ wide. Neck lacking. Fully mature proglottids with sperm-distended seminal receptacles first appear at 110–120 segments from scolex. Genital atria anterosinistral, their apertures 21–30 μ in depth and 33–47 μ in longitudinal diameter.

Measurements of proglottids: length by width, in microns, first (from scolex), 42×521; tenth, 63×536; hundredth, 458×797; hundred and fiftieth, 776×1200; hundred and ninetieth, 1170×776. Genital primordia first discernible in segments 20 to 25.

Ventral excretory canals much larger than dorsal ones, connected in anterior part of each proglottis by a transverse commissure. Successive cross canals connected by 3 (4 in one segment) irregularly arranged longitudinal vessels, usually one poral and two aporal from median line. No transverse commissures between dorsal canals observed. Genital ducts may pass dorsal to or between poral excretory canals with great irregularity.

Reproductive systems: Testes 37–46 in number; 70–94 μ in greatest diameter; lateral, posterior, and ventral to female reproductive organs; larger number in aporal half of segment; seldom extending beyond anterior margin of ovary or lateral to ventral longitudinal excretory canals. Vas deferens, very tortuous but with general course almost perpendicular to long axis of strobila, runs inward to an anteromedian position where it turns posteroaporad as a nearly straight tube, passing ventral to ovary, uterus, and vitellarium, thence breaking up into smaller collecting tubes. Cirrus pouch, spheroidal, 68–85 μ in diameter in mature segments; never extends as far inward as poral longitudinal excretory canals; opens into posteromedian portion of genital atrium. The deferent canal is somewhat sinuous within the cirrus pouch.

Ovary 211–318 μ wide in mature proglottid; slightly anteroporad from center of segment; coarsely lobate but not bilobed; roughly reniform with concavity directed posteriad. Paired oviducts, common oviduct, fertilization canal, Mehlis' gland, vitelline duct, and uterine stem all recognizable (Fig. 2). Common oviduct and sperm duct unite porad to Mehlis' gland to form short, aporally curved, fertilization canal which enters median posterior portion of Mehlis' gland. Vitellarium, 85–125 μ

Received for publication, July 3, 1939.

*A contribution from the Zoological Laboratory, Oklahoma Agricultural and Mechanical College, prepared under the direction of R. Chester Hughes.

wide; a compact mass directly posteriad to central part of ovary. Mehlis' gland and ootype located between ovary and vitellarium, definitely nearer the latter. Uterus, in mature proglottis, a narrow longitudinal canal extending anterosubporad from ootype and Mehlis' gland, ventrad to ovary and oviduct, then curving slightly aporad, to end apparently in a slight dilatation near anterior margin of ovary. Vagina, slightly sinuous; leads inward from genital atrium behind cirrus pouch in a mediosubposteriad direction. Seminal receptacle present, 40–45 μ wide and 94–134 μ long; smoothly ellipsoidal; comprises approximately one-fifth of length of vagina; ventral to poral border of ovary. Oncospheres 36–47 μ in diameter.

Anomaly: In one of the 15 strobilae studied, a single segment was observed which had a dextral atrium.

Host: Spilogale interrupta (Rafinesque 1820), the spotted skunk.

Locality: Perkins, Payne County, Oklahoma.

Cotype specimens: Two complete strobilae mounted in toto, each on a series of microscope slides, in U. S. Nat. Mus. Helm. Coll.

DISCUSSION

According to Hughes (1940) the genus *Oochoristica* Lühe 1898 contains some 44 recognized-as-valid species parasitic as adults in reptiles and mammals. The mammalian species include nine thus far not reported from carnivores: (1) *O. didelphidis* (Rudolphi 1819) Zschokke 1904, (2) *O. megastoma* (Diesing 1850) Zschokke 1905, (3) *O. tetragonocephala* (Bremser 1856) von Janicki 1904, (4) *O. surinamensis* Cohn 1902, (5) *O. bivittata* von Janicki 1904, (6) *O. parva* (von Janicki 1904) Baer 1935, (7) *O. lemuris* (Beddard 1916) Baer 1926, (8) *O. taborensis* Loewen 1934, and (9) *O. symmetrica* (Baylis 1927) mihi; and seven from carnivores: (10) *O. incisa* Railliet 1899, (11) *O. herpestis* Kofend 1917, (12) *O. erinacei* Meggitt 1920, (13) *O. ichneumontis* Baer 1926, (14) *O. mephitis* Skinker 1935, (15) *O. sandgroundi* Baer 1935, and (16) *O. oklahomensis* n. sp. Some of the carnivoran species have also been reported from other mammals. For important discussions on synonymy the reader is referred to Meggitt (1934), Skinker (1935), and Baer (1935). Apparently the only mammalian species thus far reported from North America are *O. taborensis* from *Lasiurus borealis borealis* in Kansas, *O. mephitis* from *Mephitis elongata* in Georgia, and *O. oklahomensis*.

The new species was studied in comparison with all of the above-mentioned previously described mammalian forms, utilizing for the purpose the original descriptions of *O. parva* (von Janicki 1904), *O. taborensis* (Loewen 1934), and *O. mephitis* (Skinker 1935) and data tabulated by Meggitt (1934) and Skinker (1935) for the 11 others. It was also compared with descriptions of, or tabulated data on, all of the 28 reptilian species.

The new form differs from the previously described carnivoran species of *Oochoristica* as follows:

from *O. incisa* in having (1) larger suckers, (2) a much smaller cirrus pouch, (3) much larger oncospheres, and (4) a New World distribution;

from *O. herpestis* in having (1) a much narrower strobila, (2) a much larger scolex, (3) a much smaller cirrus pouch which does not reach poral excretory canals, (4) fewer testes, and (5) a New World distribution;

from *O. erinacei* in having (1) a much larger general size, (2) the cirrus pouch actually and relatively very much smaller and not reaching poral excretory vessels, (3) a larger number of testes, (4) a seminal receptacle, (5) larger eggs, and (6) a New World distribution;

from *O. ichneumontis* in having (1) a much narrower strobila, (2) a much smaller cirrus pouch, (3) much fewer testes, (4) a seminal receptacle, and (5) a New World distribution;

from *O. mephitis* in having (1) a much longer strobila, (2) a relatively shorter cirrus pouch, (3) fewer testes, and (4) larger eggs; and,

from *O. sandgroundi* in having (1) a much larger strobila, (2) a somewhat smaller scolex, (3) larger suckers, and (4) the cirrus pouch actually and relatively smaller and not reaching poral excretory vessels.

Bibliography

Baer, J. G. 1935 Etude de quelques helminthes de lémuriens. Rev. Suisse Zool. **42**: 275–291.

Hughes, R. C. 1940 The genus *Oochoristica* Lühe 1898. Am. Midland Naturalist **23** (in press).

von Janicki, C. 1904 Sur Kenntnis einiger Säugetiercestoden. Zool. Anz. **27**: 770–782.

Loewen, S. L. 1934 A new cestode from a bat. Tr. Kansas Acad. Sc. **37**: 257–261.

Meggitt, F. J. 1934 On some tapeworms from the bullsnake (*Pituophis sayi*), with remarks on the species of the genus *Oochoristica* (Cestoda). J. Parasitol. **20**: 181–189.

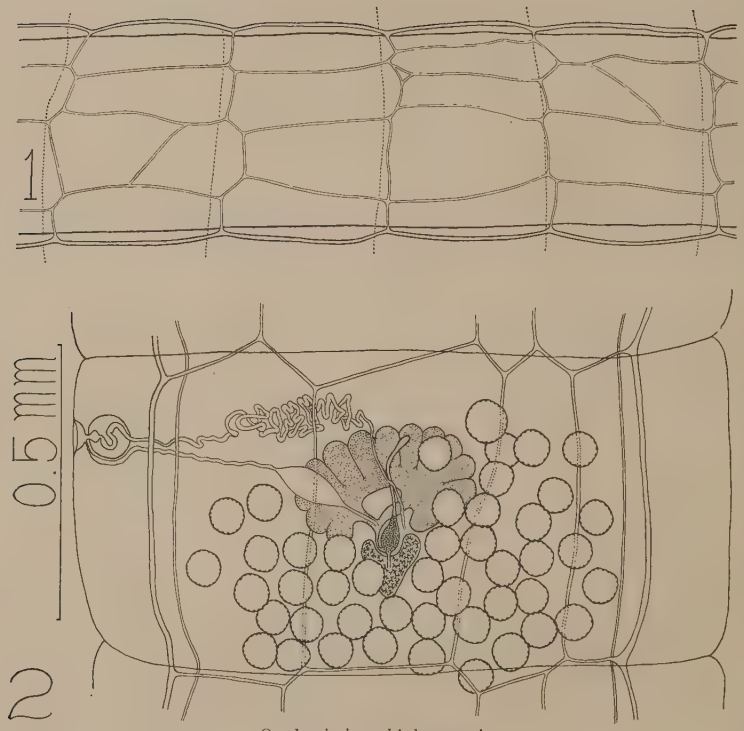
Skinker, M. S. 1935 A new species of *Oochoristica* from a skunk. J. Washington Acad. Sc. **25**: 59–65.

Explanation of Plate

Both figures concern *Oochoristica oklahomensis* n. sp.

Fig. 1. Pattern of excretory canals in four consecutive segments, their front ends toward the left. Dorsal canals represented in solid lines. A freehand study.

Fig. 2. A mature proglottid, ventral view. Drawn with the aid of a projection apparatus.



Oochoristica oklahomensis

THE METACERCARIA OF *AMPHIMERUS ELONGATUS* GOWER (TREMATODA: OPISTHORCHIIDAE)

F. G. Wallace
Department of Zoology, University of Minnesota

In May, 1939, numerous metacercariae of several types were found in the minnow, *Notropis deliciosus stramineus,* from Lake Francis, Isanti County, Minnesota. One of these developed in chicks and ducklings into *Amphimerus elongatus.* This species was described by Gower (1938), who found it in eight species of ducks and two species of swans and produced infections in young ducks by feeding them bass, perch, and blue gills. He did not identify the larval flukes or determine which of the possible fish hosts carried them.

MATERIAL AND METHODS

Metacercariae were isolated from the fish by peptic digestion. Entire fishes were passed through a meat grinder and lightly triturated in a mortar. Artificial gastric juice was made by adding 0.7 gram of scale pepsin to 100 cc of a 0.4 per cent solution of HCl. Ground fish, not more than 10 grams per 100 cc of fluid, and glass beads were added to the gastric juice and incubated for two hours or more at 37.5° C with occasional shaking. When no large particles of flesh remained the mixture was poured through a tea strainer into 1 liter sedimenting cylinders and washed with two or three changes of tap water at intervals of 20 minutes. After the last washing the sediment was poured into a petri plate where the cysts could be isolated under the binocular microscope. A few fish were dissected to show the location of the cysts. Excysted metacercariae were obtained by incubating the cysts a few minutes in artificial pancreatic juice made by adding a small amount of pancreatin to a 0.1 per cent solution of $NaHCO_3$.

Description of Metacercaria

Cyst (Fig. 1) oval, 0.162 mm to 0.180 mm, average 0.173 mm in length by 0.124 mm to 0.144 mm, average 0.173 mm in width and enclosed in unpigmented connective tissue capsule of host origin which is usually removed by peptic digestion. Cyst wall transparent and colorless; 8 μ to 12 μ thick, usually thickest at ends of cyst, and composed of three layers; an inner membrane which is visible only when the outer cyst wall is digested away by pancreatin and the cyst wall proper which is faintly divided into an inner thicker and an outer thinner layer. Metacercaria moves actively in cyst; usually folded twice.

Excysted metacercaria (Fig. 2) 0.45 mm to 0.51 mm long and 0.07 mm to 0.09 mm wide. Nine sensory papillae visible along margin of anterior half of body on each side. Body densely covered with scale-like spines 3 μ to 3.5 μ long. Oral sucker 0.042 mm to 0.045 mm wide by 0.050 mm to 0.053 mm long. Acetabulum

Received for publication, July 25, 1939.

almost perfectly circular, 0.050 mm to 0.053 mm in diameter. Pharynx 0.040 mm to 0.042 mm long by 0.018 mm to 0.020 mm long. Prepharynx about same length as pharynx. Ceca arise from esophagus midway between pharynx and acetabulum and

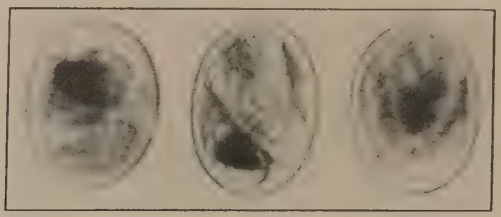


FIG. 1. Photographs of cysts of *Amphimerus elongatus* isolated by peptic digestion. ×150.

extend to posterior end of body. Disk-shaped concretions, 7 μ to 8 μ in diameter present in esophagus and ceca. Excretory vesicle thin-walled and unbranched. A collecting tubule arises from each antero-lateral corner of vesicle and extends anteriorly to level of pharynx where it divides into an anterior and a posterior branch. Eight ducts open on dorsal lip of oral sucker. These lead from what appear to be an equal number of unicellular, interocecal, preacetabular glands. Genital primordium a trilobed cluster of cells between excretory vesicle and acetabulum. Oviduct leads from this to genital pore just anterior to acetabulum.

FIG. 2. Ventral view of excysted metacercaria of *Amphimerus elongatus.*

Metacercariae were found chiefly in the muscles of the fish though a very few were seen in the fin rays.

Heinemann (1937) described an outer thin membrane, separated by a fluid-filled space from the inner cyst in *Metorchis xanthosomus.* He regarded this outer membrane as a part of the cyst and as being of parasitic origin. A similar membrane has been seen around some of the present cysts which have been in saline or in water. However the connective tissue capsule always invests the cyst closely when it is freshly dissected from the flesh, so the author believes that at least in *A. elongatus* this outer membrane, whether it is the outer layer of the cyst or is a part of the connective tissue capsule, appears as a result of osmotic or cover glass pressure.

While the metacercariae of several other species of OPISTHORCHIIDAE are known, namely: *Pseudamphistomum danubiense* and *Metorchis albidus* as described by Ciurea (1917), *Pseudamphistomum truncatum* by Schuurmans Stekhoven (1931), *Opisthorchis tenuicollis* (= *O. felineus*)

by Vogel (1934), *Clonorchis sinensis, Metorchis orientalis,* and *M. taiwanensis* by Hsü and Khaw (1936), and *Metorchis xanthosomus* by Heinemann (1937), this is the first metacercaria of a fluke of the genus *Amphimerus* to be described. This larva resembles those of the eight species cited above in the unpigmented capsule, transparent cyst wall, spination, general arrangement of suckers, alimentary canal, and genital pore, and in the oblong, unbranched excretory vesicle. It differs from the metacercariae of *Clonorchis* and *Opisthorchis* in that the cyst walls of these forms do not exceed 3 in thickness. The cysts of the *Metorchis* and *Pseudamphistomum* species all exceed .200 mm in length. The long narrow pharynx of the metacercaria of *A. elongatus* distinguishes it from all the above cited forms except *P. danubiense.*

EXPERIMENTAL INFECTIONS

Twelve chickens and two ducks were infected during the course of the work. The first experimental birds received mixed doses of several types of metacercariae but seven chickens and one duck were fed only the type of metacercaria described above. In most of the experiments newly-hatched birds were used but two chickens approximately two and a half months of age appeared to be no less susceptible to the parasite than the younger chicks. Worms were recovered from chickens 1, 2, 3, 4, 7, 8, 12, 20, and 45 days after infection and from ducks 7 and 72 days after infection.

The growth of this parasite is surprisingly rapid, the microscopic larva attaining sexual maturity and a length of more than a centimeter after only seven days in the definitive host. In the 72 day duck a number of worms were found in the liver but all were dead and disintegrating. Gower reports that one of his experimental ducks recovered from visible symptoms about two months after infection.

The outstanding morphological feature of *Amphimerus elongatus* in the adult stage is the complete absence of the oral sucker. The study of a series of young worms recovered from chicks at one day intervals after infection shows that this organ, which is well developed in the metacercaria, is completely lost by the fourth day. The disappearance of the sucker is effected not by a reduction in its size but by a gradual weakening and disappearance of the muscle fibers of the entire organ.

The adult worms reared in this study agreed in all essential points with Gower's description of *A. elongatus* though in the present specimens the ovary and testes were more deeply lobed than in Gower's figure. Gower found the pancreatic ducts to be the chief site of infection, the liver being less heavily infected in most cases. In the present study the parasites were found in the pancreas of only one chicken while they were present in the livers of all 14 experimental birds. In the liver the worms

were not found in the ducts after the second day of infection but, as sections show, were imbedded directly in the liver tissue. Many of them migrate to the surface of the organ where in heavy infections they can be seen easily on gross examination, sometimes even through the abdominal wall.

Bibliography

Ciurea, J. 1917 Die Auffindung der Larven von *Opisthorchis felineus, Pseudamphistomum danubiense,* und *Metorchis albidus* und die morphologische Entwicklung dieser Larven zu den geschlechtsreifen Würmern. Z. Infektionskr. Haustiere. **18**: 301–338, 345–357.

Gower, W. Carl. 1938 Studies on the trematode parasites of ducks in Michigan with special reference to the mallard. Memoir 3, Agric. Exper. Sta., Michigan State College. pp. 1–94.

Heinemann, E. 1937 Über den Entwicklungskreislauf der Trematodengattung *Metorchis* sowie Bemerkungen zur Systematik dieser Gattung. Z. Parasitenk. **9**: 237–260.

Hsü, H. F. and O. K. Khaw. 1936 Studies on certain problems of *Clonorchis sinensis.* I. On the cysts and second intermediate hosts of *C. sinensis* in the Peiping area. Chinese Med. J. **50**: 1609–1620.

Schuurmans Stekhoven, J. H. 1931 Der 2. Zwischenwirt von *Pseudamphistomum truncatum* (Rud.) nebst Beobachtungen über andere Trematodenlarven. Z. Parasitenk. **3**: 747–764.

Vogel, Hans. 1934 Der Entwicklungszyklus von *Opisthorchis felineus* (Riv.) nebst Bemerkungen über die Systematik und Epidemiologie. Zoologica No. 86: 1–103.

TATRIA DUODECACANTHA, A NEW SPECIES OF CESTODE (AMABILIIDAE BRAUN, 1900) FROM THE PIED-BILLED GREBE (*PODILYMBUS PODICEPS PODICEPS* (LINN.))[1,2]

O. Wilford Olsen

A series of fifty slides of a minute cestode collected from the pied-billed grebe in Iowa was submitted to the writer by Dr. Robert L. Roudabush for identification. Examination of the specimens revealed them to be an undescribed species of the genus *Tatria* Kowalewski 1904, and closely related to *T. biremis* Kowalewski 1904, from the European grebes, *Colymbus auritus* Linn., and *C. nigricollis* (Brehm).

The name *Tatria duodecacantha* n. sp. is proposed, being suggested by the number of rostellar hooks.

Tatria duodecacantha n. sp.
(Figs. 1–4; 8; 10–14)

Description: Small cestodes consisting of about 20 proglottides and attaining a total length of 2.3 mm. Proglottides with posterio-lateral prolongations which become increasingly longer toward caudal end of strobila. Maximum width of segments 356 μ, including prolongation 567 μ, length of terminal segments up to 235 μ. Scolex triangular from dorsal or ventral view but rectangular in cross sections, being flattened dorso-ventrally, width 171–250 μ, length about 162 μ; everted rostellum 266–380 μ long, diameter of enlarged distal end 57–76 μ; suckers 106–180 μ long by 76–83 μ wide, margins and inside lined with numerous minute spines which were not seen elsewhere on scolex. Rostellum with a single crown of 10–13, usually 12, hooks, 25–27 μ long, relative proportions of parts of hooks being dorsal root 15–17 μ, blade 10–12 μ and ventral root about 3 μ long. Of 53 specimens examined 4 percent had 10 hooks, 13 percent had 11, 81 percent had 12 and 2 percent had 13. Neck 76–87 μ long by 114–178 μ wide.

Genital pores regularly alternate, opening near posterior limit of first third of lateral margins in anterior segments but of first quarter in posterior proglottides where posterio-lateral elongations have developed to a greater extent. Genital ducts pass between longitudinal excretory vessels. Cirrus pouches 80–87 μ long by 30–38 μ wide, extending to or slightly beyond excretory canals; cirrus heavily armed with stout backward curving spines, internal seminal vesicle small and spherical with a thick wall composed of cuboidal cells (Fig. 3) which continues as a short narrow tube connecting with the large external seminal vesicle, 30–38 μ wide by 50–68 μ long, its wall consisting of large columnar cells (Fig. 3) that persist until uterus appears when it becomes greatly distended with spermatozoa, the cells then show a remarkable elasticity, stretching laterally so as to assume a squamate appearance (Fig. 4); vas deferens extends obliquely from median border of external seminal vesicle toward testes; 6–9 testes, dorsal to ovary and in posterior portion of segment, 38–46 μ in diameter. Vagina seen once in sections, located caudad and dorsad from cirrus pouch (Fig. 12), pore caudad, connection with seminal receptacle not seen but

Received for publication, July 28, 1939.

[1] Paper No. 1728. Scientific Journal Series, Minnesota Agricultural Experiment Station, St. Paul.

[2] In cooperation with Minnesota Conservation Department, Division of Game and Fish.

probably near external seminal vesicle (Fig. 12). Seminal receptacle a large elongated sac extending transversely across entire width of anterior margin of proglottid and continuous through entire strobila, it connects between segments by means of a narrow tube extending posteriorly from poral side, passing between excretory canals on poral side near level of cirrus pouch and dorsal to them on poral side (Fig. 2); proximal portion of vagina extends caudad as a narrow duct leading from seminal receptacle near median line thence dorsad from ovary to its caudal margin, then bends ventrad and cephalad to form oviduct (Fig. 2); ovary transversely elongated, slightly convex anteriorly and concave posteriorly, length 133 μ, width 38 μ, ovarian cells large (Figs. 11, 12, 13) vitelline gland spherical, located in concavity at caudal margin of ovary, diameter about 24 μ. Uterus appears suddenly, anywhere from second to eighth segments from posterior end at which time testes and ovary disappear, shape oval, walls smooth and even (Fig. 1), fills medullary parenchyma, persistent. Ova few, mature ones not seen.

Host: Podilymbus podiceps podiceps (Linn.)

Habitat: Intestine.

Locality: Iowa, U. S. America.

Type specimen: U. S. Nat. Mus. Helm. Coll. No. 9282; paratypes No. 9283. Other paratypes at University of Minnesota and Iowa State College Helm. Coll. and in collection of author.

DISCUSSION

Tatria duodecacantha n. sp. differs from the four known species of the genus in the number, the shape or the size of the rostellar hooks. In the case of *T. appendiculata* Fuhrmann, 1908 from the Mexican grebe, *Colymbus dominicus brachypterus* Chapman, the hooks are of the same size but of a different shape and fewer in number, while in *T. biremis* Kowalewski, 1904, the hooks are the same shape but almost twice as long and fewer. The only internal structures visible to Fuhrmann in the specimens of *T. appendiculata* were the cirrus pouches and uteri, a condition which makes a detailed comparison of this species with the other members of the genus impossible at this time. Differentiation of *T. appendiculata* and *T. duodecacantha* must be made upon the shape and number of the rostellar hooks. While Fuhrmann did not describe the hooks of *T. appendiculata*, his figure shows one with a very short ventral root and a blade having a regular and even dorsal convexity throughout its entire length (Fig. 9). In the case of *T. duodecacantha*, however, the shape is different there being a pronounced "hump" over the ventral root and the dorsal line of the blade is concave instead of convex (Fig. 8). Although Fuhrmann recorded the number of rostellar hooks as being ten, he did not make any mention of the number of specimens examined nor whether there was any variation in the number present. In the fifty-three specimens of *T. duodecacantha* examined, the number of hooks ranged from ten to thirteen with the extremes occurring in two and one specimens, respectively, while seven individuals had eleven hooks and forty-three, *i.e.*, 81 percent, had twelve hooks. The probability of encountering a specimen of *T. duodecacantha* with ten hooks is two in fifty-three times.

T. duodecacantha resembles *T. biremis* both in the shape of the rostel-

lar hooks and the internal structure, particularly in the manner in which the seminal receptacle loops from one segment to the next as a continuous structure (Fig. 2). They differ, however, in that the former has twelve rostellar hooks which are 25–27 μ long while the latter has ten hooks which are 44–50 μ long. In addition, there are about thirty rows of minute hooklets encircling the rostellar stalk but they are absent in *T. duodecacantha*.

T. acanthorhyncha (Wedl, 1855) and *T. decacantha* Fuhrmann, 1913 differ from the other species in the shape of the rostellar hooks in that the ventral root is much longer than the dorsal root and also in the arrangement of the seminal receptacle which is median and continuous throughout the strobila whereas in *T. duodecacantha* and *T. biremis* it lies transversely across the anterior part of the proglottid, passing caudad on the poral side to connect with that of the following segment.

The following key, together with the figures of the hooks, will serve to further differentiate the known species.

Key to the Species of *Tatria*

1. Hooks with dorsal root longer than ventral root 2
   Hooks with dorsal root many times shorter than ventral root 4
2. Hooks 44–50 μ long; about 30 rows of minute hooklets on rostellar stalk behind crown of 10 large hooks (Fig. 7). ..... *Tatria biremis* Kowalewski, 1904
   Hooks 27 μ or less in length 3
3. Hooks with very short ventral root; dorsal curvature of blade an even convexity extending from level of ventral root to tip; hooks 10; no spines on scolex (Fig. 9) ..... *T. appendiculata* Fuhrmann, 1908
   Hooks with a ventral root fully one third as long as blade, a pronounced hump over base of latter, dorsal curvature of blade an even concavity extending from hump to tip; hooks nearly always 12, rarely 10, suckers thickly covered inside and out with minute spines (Fig. 8) ..... *Tatria duodecacantha* n. sp.
4. With 10 rostellar hooks 19.8–21 μ long, blade distinctly longer than ventral root; strobilae up to 1.1 mm long. (Fig. 5). *Tatria decacantha* Fuhrmann, 1913
   With 14 rostellar hooks 19–24 μ long, blade and ventral root equal in length; strobilae 2–10 mm long (Fig. 6) ..... *Tatria acanthorhyncha* (Wedl, 1855)

Bibliography

Fuhrmann, O. 1908 Nouveaux ténias d' oiseaux. Rev. suisse Zool. **16**: 27–73.
———1913 Nordische Vogelcestoden aus dem Museum von Göteborg. Meddelanden fran Göteborgs Musei Zologiska Afd. **1**, 41 pp.
Joyeux, Ch. and J. G. Baer. 1936 Faune de France 30. Cestodes. Paris. 613 pp.
Kowalewski, M. 1904 Study helmintologiczne, cześc VIII. O nowym tasiencu: *Tatria biremis*, gen nov., sp. nov. (Helminthological studies, part VIII. On a new tapeworm: *Tatria biremis*, gen. nov., sp. nov.). Bull. Acad. Sc. Cravocie et Sc. Mat. et Nat. **44**: 367–369.
Mrzak, Al. 1905 Ueber *Taenia acanthorhyncha* Wedl. (Ein Beitrag zur Kenntnis der Gattung *Tatria* Kowalewski). Sitzb. kgl. böhm. Ges. Wiss. Math. Nat. Cl. Prague 24 pp.
Wedl, C. 1855 Charakteristik mehrerer grösstenteils neuer Taenien. Sitzb. Akad. Wiss. Wien, Math. Nat. Cl. **18**: 5–27.

Explanation of Plate

All drawings made with the aid of a camera lucida. With the exception of Figs. 5, 6, 7 and 9, all refer to *Tatria duodecacantha.*

Abbreviations

C	cirrus
CP	cirrus pouch
DE	dorsal excretory canal
O	ovary
OD	oviduct
SI	internal seminal vesicle
SR	seminal receptacle
SV	external seminal vesicle
T	testes
U	uterus
V	vagina
VE	ventral excretory canal
VG	vitelline gland

Fig. 1. Sexually mature *Tatria duodecacantha.*

Fig. 2. Detailed anatomy of three sexually mature proglottides. Partially reconstructed from sections.

Fig. 3. Cirrus pouch with cirrus extruded and internal and external seminal vesicles. Cells of external seminal vesicle have a columnar appearance prior to the time when it is filled with spermatozoa.

Fig. 4. Cirrus pouch and seminal vesicles, showing squamose character of the cells of the external seminal vesicle when it is distended with spermatozoa.

Fig. 5. Rostellar hooks of *Tatria decacantha* Fuhrmann, 1913. After Joyeux and Baer 1936.

Fig. 6. Rostellar hook of *Tatria acanthorhyncha* (Wedl, 1856). After Joyeux and Baer, 1936.

Fig. 7. Rostellar hook of *Tatria biremis* Kowalewski, 1904. After Kowalewski, 1904.

Fig. 8. Rostellar hook of *Tatria duodecacantha* n. sp.

Fig. 9. Rostellar hook of *Tatria appendiculata* Fuhrmann, 1908. After Fuhrmann, 1908.

Fig. 10. Scolex with rostellum inverted.

Fig. 11. Frontal section of two proglottides showing arrangement of seminal receptacle ventral view.

Fig. 12. Cephalic view of proglottid showing transverse portion of seminal receptacle. Section taken through anterior portion of proglottid.

Fig. 13. Transverse section through posterior portion of same proglottid (Fig. 12) showing narrow portion of seminal receptacle connecting between the two segments. Cephalic view.

Fig. 14. Scolex with rostellum everted.

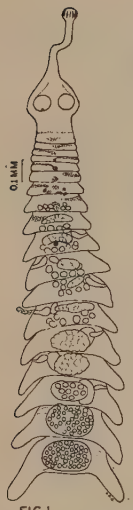


FIG. 1

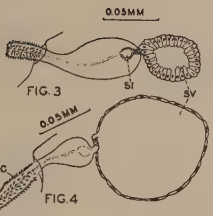


FIG. 3
FIG. 4

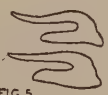


FIG. 5

FIG. 6

FIG. 7

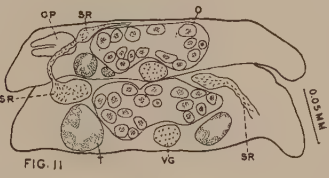


FIG. 11

FIG. 12

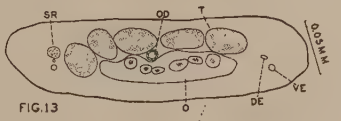


FIG. 13

FIG. 8

FIG. 9

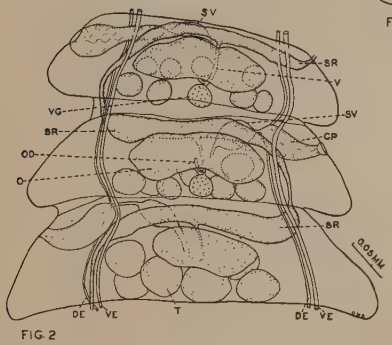


FIG. 2

FIG. 10

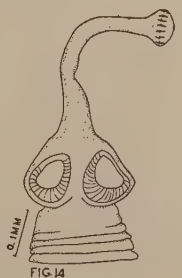


FIG. 14

STUDIES ON MONOGENETIC TREMATODES. I. NEW SPECIES FROM THE WARMOUTH BASS*

JOHN D. MIZELLE AND AARON SEAMSTER

In the fall of 1938 Dr. R. V. Bangham (Department of Zoology, College of Wooster, Wooster, Ohio) sent one of the authors (Mizelle) an extensive collection of formalin-preserved monogenetic trematodes which he obtained during the same year from various fishes in Florida and Tennessee. A series of studies on this collection has been undertaken to present, chiefly, (1) descriptions of new forms, (2) new host records, (3) new distribution records, and (4) structural variations of known forms that obtain under different environmental conditions. This is the first of these studies to appear.

The authors have found that field-preserved gyrodactyloid trematodes frequently do not lend themselves well to research studies, consequently, little progress was made during the present investigation until a suitable method for handling this material was determined. The writers are especially indebted to Professor G. A. Moore of this department, who suggested the use of a "fish scale" medium (Van Oosten, 1923) which proved very satisfactory. This mixture consists of glycerin, gelatin sufficient for solidification on cooling, and a bit of phenol for preservation. Use of this medium facilitated study by enabling us (1) to produce mounts suitable for microscopic study and (2) to mount specimens directly from the formalin preservative. The latter entails a saving of time and material in contrast to methods requiring dehydration. Later a "glychrogel" medium (Wotton and Zwemer, 1935) was used also with favorable results. Although the above procedures are satisfactory, it is not to be inferred that preserved material is as favorable as fresh material for detailed studies on fresh-water GYRODACTYLOIDEA.

Numerous papers on GYRODACTYLOIDEA, chiefly, by Mueller, Price, and Mizelle, have appeared during the last few years. The literature, anatomy, and structural nomenclature concerning the group have been adequately reviewed inter se by Price (1938), Mizelle (1936, 1938,) and Mizelle and Hughes (1938). Thus far no publication has dealt with descriptions of gyrodactyloid trematodes from the warmouth bass. Mueller (1937) in a discussion of host relationships states that "Althqugh too few specimens have been examined to permit definite conclusions as yet, it appears that the war-mouth bass (*Chaenobryttus*) possesses a similar immunity . . ."—no gyrodactyloid parasites having been found on the forms having the immunity.

Received for publication, August 12, 1939.

* Contribution from the Zoological Laboratory, Oklahoma Agricultural and Mechanical College, Stillwater.

Measurements of critical structures do not follow curves but were made across the arcs formed by them. Anchor lengths were taken between the tip of the most anterior-projecting anchor root and the region of junction (curved portion) of the shafts and points. Anchor widths represent straight lines, at right angles to the shaft axis, connecting the two most distant margins of the base. Haptoral lengths do not include anchor parts that project beyond the posterior edge of the haptor.

Urocleidus grandis n. sp.
Figs. 1–7

Description: Small dactylogyrids usually with a smooth cuticula. Length 0.395 mm (0.257–0.595 mm), greatest width 0.082 mm (0.060–0.097 mm). Eye spots four —those of posterior pair larger and closer together. Pharynx transversely elongate, ovate in outline; greatest diameter 0.028 mm (0.024–0.031 mm). Haptor subhexagonal to discoidal in shape, peduncle stout. Width of haptor 0.081 mm (0.064–0.096 mm), length 0.065 mm (0.060–0.075 mm). Bars similar in shape, bent posteriorly in midportions, ends knob-like and each end articulated to mesial side of an anchor base. Posterior margin of midportion of each bar with an apron-like plate. Apron of ventral bar split posteriorly and with an opening near central portion. Length of ventral bar 0.036 mm (0.030–0.039 mm), length of dorsal bar 0.034 mm (0.030–0.037 mm). Anchors comparatively large and dissimilar in shape and size (dorsals larger). Solid shafts and points junction sharply to produce a fish-hook appearance. A spur-like projection present near terminal portion of each anchor shaft. Anchor bases nonbifurcate, superficial part of each base longer than deep portion and generally bent mesiad. Length of ventral anchors 0.047 mm (0.043–0.051 mm), width 0.019 mm (0.017–0.021 mm). Length of dorsal anchors 0.062 mm (0.057–0.066 mm). (Orientation of dorsal anchors did not permit measurement of width.) Anchor wings not distinguishable. Hook arrangement typical of the genus. Each hook (except members of pair number five) differentiated into an elongate hollow base, a short solid shaft, a sickle-shaped termination, and an opposable piece. All hooks, except members of pair number five, approximately the same length (members of pair number one slightly shorter than others); hook lengths 0.021–0.029 mm. Hook pair number five about 0.010–0.017 mm long; bases subspherical, shafts solid and slender. Testis ovate in outline; about same size as, situated posterior to, and with anterior margin dorsally overlapping posterior end of, the longitudinally elongate, ovate ovary. Copulatory complex consisting of a cirrus and cirral thread. Cirrus a comparatively large tapered chitinous tube with a pointed end; length 0.044 mm (0.041–0.047 mm). Vagina absent. Vitellaria characteristic of the genus.

Type Host and Localities: Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes). Roadside Canal, Naples, Fla. and Woodmere Pond, Englewood, Fla.

Site of Infestation: Gills.

Number of specimens used in this investigation: Three.

Type Specimens: Cotypes No. 9298, U. S. Nat. Mus., Washington, D. C.

This species is interesting because it possesses a combination of characters used for separation of three old genera, namely, *Aristocleidus* Mueller, 1936, (anchors dissimilar in shape); *Haplocleidus* Mueller, 1937, (anchors dissimilar in size); and *Pterocleidus* Mueller, 1937 ("spurs" on anchor shafts). Possession of such characters lends support to the incorporation of these three genera in the genus *Urocleidus* Mueller, 1934, by Mizelle and Hughes (1938). Articulation of the bars

to the mesiolateral surfaces of the anchor bases, is a distinctive character of this species. Characters of the anchors, bars, and copulatory complex make the assignment of this species to the genus *Urocleidus* very clear.

Urocleidus chaenobryttus n. sp.
Figs. 8–20

Description: Small dactylogyrid parasites with smooth cuticula. Length 0.325 mm (0.245–0.380 mm), greatest width 0.087 mm (0.052–0.108mm). Posterior eye spots larger and closer together than members of anterior pair. Pharynx subcircular in outline, transverse diameter 0.024 mm (0.019–0.028 mm). Haptor pentagonal in outline, longer than wide, and well set off from body by a peduncle. Width of haptor 0.077 mm (0.054–0.086 mm), length 0.081 mm (0.067–0.094 mm). Bars similar in shape and size, bent posteriorly in midportions, and with ends modified to form knob-like structures. Dorsal bar often with a median, posterior projection similar to that of dorsal bar of *Urocleidus mucronatus* (Mizelle, 1936). Length of ventral bar 0.025 mm (0.024–0.026 mm), length of dorsal bar 0.028 mm (0.026–0.029 mm). Anchors similar in shape and size; comparatively long solid shafts and points junction sharply to form an internal angle. Anchor bases bifurcate, superficial roots much longer than deep roots. Superficial roots of ventral anchor bases generally bent toward axis of shaft. Length of ventral anchors 0.063 mm (0.057–0.068 mm), width 0.014 mm (0.012–0.015 mm). Length of dorsal anchors 0.062 mm (0.057–0.064 mm), width 0.015 mm (0.013–0.018 mm). Anchor wings well developed. Hook arrangement typical of the genus. Each hook consists of an elongate hollow shaft (except members of pair number five), a terminal sickle-shaped structure, and an opposable piece. Hooks of pair number five, comparatively short (0.010–0.013 mm) and with solid shafts and relatively longer terminations. Hook pair number five located between shafts of ventral anchors. Lengths of remaining hooks 0.032–0.040 mm. Testis longitudinally elongate, ovate in outline, and situated posterior to the smaller ovary. Copulatory complex composed of a slender undulating cirrus and cirral thread. Cirrus length 0.060 mm (0.055–0.067 mm). Vagina apparently wanting. Vitellaria characteristic of the genus.

Type Host and Locality: Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes). Roadside Canal, Naples, Fla.; Roadside Ditch, Englewood, Fla.; and Woodmere Pond, Englewood, Fla.

Site of Infestation: Gills.

Number of specimens used in this investigation: Six.

Type Specimens: Cotypes No. 9299, U. S. Nat. Mus., Washington, D. C.

With reference to the haptoral armament, this species superficially resembles *Urocleidus ferox* (Mueller, 1934) from the pumpkinseed sunfish (*Lepomis gibbosus*) and *Urocleidus mucronatus* (Mizelle, 1936) taken from the pumpkinseed, bluegill (*Lepomis macrochirus*), orange-spotted sunfish (*Lepomis humilis*), and hybrids between these species. Both bars in *U. mucronatus* possess a median spine; this structure is occasionally found and only on the dorsal bar in *Urocleidus chaenobryttus;* neither bar is spined in *U. ferox.* Shapes of the anchors are similar in all three species, however, various differences are present with reference to the occurrence of cavities within, and the shapes of the hooks. A vagina is lacking in *U. chaenobryttus* but is present (dextral) in each of its near relatives. The copulatory complexes are distinctive in all three species.

Actinocleidus okeechobeensis n. sp.
Figs. 21–34

Description: Medium-sized dactylogyrids devoid of body scales. Length 0.810–1.183 mm, greatest body width 0.213–0.315 mm. Posterior eye spots larger and about same distance apart as members of anterior pair. Pharynx circular in outline, diameter 0.060–0.093 mm. Haptor discoidal in shape, poorly set off from the body, and broader than long. Haptoral width 0.172–0.195 mm, length 0.092–0.120 mm. Anterior bar bent posteriorly in midportion, a notch present on posterior surface near each end; length 0.035–0.036 mm. Posterior bar bifurcate to form two posteriorly projecting rami, each of which possesses a subterminal notch on outer surface. Distance across widest portion (rami) of posterior bar 0.022–0.025 mm. Anchors regularly recurved and similar in shape; wings barely evident on shafts. Anchor points and distal portions of shafts, hollow. Anchor bases slightly bifurcate, superficial roots long, deep roots reduced. Length of anterior anchors 0.039–0.040 mm, width 0.011–0.017 mm. Length of posterior anchors about 0.035 mm, width 0.013–0.014 mm. Each hook differentiated into a small subspherical base, a slender solid shaft, a sickle-shaped termination, and an opposable piece. Hook arrangement modified in that pairs numbers six and seven are located on posterior dorsal border of haptor instead of toward its dorsal center. Hook pair number five located between bars and may project laterally or posteriorly. Hook lengths 0.008–0.015 mm, hook pairs numbers two, three, and four longer than remaining hooks. Gonads near midlength of body. Testis longitudinally elongate, ovate; situated posterodorsal to, and with anterior border overlapping rear portion of, ovary. Greatest diameter of testis 0.087–0.121 mm. Copulatory complex composed of a cirrus and accessory piece basally articulate with each other. Cirrus a thin curved chitinous tube with a large base and tapered shaft. Cirrus length 0.049–0.051 mm. Accessory piece shorter than, and partly enclosing the cirrus. Ovary circular to ovate in outline, smaller than testis, and 0.077–0.081 mm in greatest diameter. Vagina apparently wanting. Vitellaria well developed and characteristic of the genus.

Type Host and Locality: Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes). Lake Okeechobee, Moore Haven, Fla.

Site of Infestation: Gills.

Number of specimens used in this investigation: Two.

Type Specimens: Cotypes No. 9300, U. S. Nat. Mus., Washington, D. C.

The nature of the haptoral armament and copulatory complex makes the assignment of this species to the genus *Actinocleidus* Mueller, 1937, very definite. The shapes of the cirrus and accessory piece in this form are diagnostic.

Actinocleidus flagellatus n. sp.
Figs. 35–41

Description: Small dactylogyrids with smooth cuticula. Length 0.269 mm (0.230–0.284 mm), greatest width 0.069 mm (0.050–0.090 mm). Posterior eye spots larger and closer than members of anterior pair. Pharynx subcircular in outline, diameter about 0.015 mm. Haptor quadrilateral to discoidal in shape, and set off from body by a distinct peduncle. Width of haptor 0.057 mm (0.048–0.062 mm), length 0.038 mm (0.030–0.046 mm). Bars similar in shape, bent toward each other, and apparently confluent, in midportions. Length of anterior bar 0.035 mm (0.031–0.038 mm), length of posterior bar 0.028 mm (0.026–0.029 mm). Anchors similar in shape and size; hollow shafts and points regularly recurved at junction without internal angle formation. Anterior anchor bases bifurcate, superficial roots comparatively long, deep roots vestigial. Length of anterior anchors 0.028 mm (0.027–0.030 mm), width 0.010–0.011 mm. Length of posterior anchors 0.025 mm (0.021–0.028 mm), width 0.009 mm (0.008–0.011 mm). Anchor wings well developed.

Hook arrangement typical of the genus. Each hook consists of a small oval base, a solid shaft, a sickle-shaped termination, and an opposable piece. Hooks approximately the same length (0.010–0.014 mm.). Testis ovate in outline; larger than, and situated posterior to, the longitudinally elongate, ovate ovary. Copulatory complex consisting of basally articulate cirrus and accessory piece. Cirrus a curved tapered, chitinous tube with a recurved tip; length 0.055 mm. (0.050–0.059 mm.). Accessory piece solid, whip-like, and about same length as cirrus. Vagina apparently wanting. Vitellaria characteristic of the genus.

Host and Localities: Warmouth Bass, *Chaenobryttus gulosus* (Cuvier and Valenciennes). Roadside Canal, Naples, Fla., and Roadside Ditch, Englewood, Fla.

Site of Infestation: Gills.

Number of specimens used in this investigation: Three.

Type Specimens: Cotypes No. 9301 U. S. Nat. Mus., Washington, D. C.

Actinocleidus longus Mizelle, 1938, resembles *Actinocleidus flagellatus* in that the accessory pieces are both whip-like. In *A. flagellatus*, however, this structure has a raised portion near the midlength whereas it is smooth in *A. longus*. The cirrus of the present species is very short as compared with that of *A. longus*.

Bibliography

Mizelle, John D. 1936 New species of trematodes from the gills of Illinois fishes. Am. Midland Naturalist **17**: 785–806.

———1938 Comparative studies on trematodes (Gyrodactyloidea) from the gills of North American fresh-water fishes. Illinois Biol. Monogr. **17**: 1–81.

———and R. C. Hughes. 1938 The North American fresh-water Tetraonchinae. Am. Midland Naturalist **20**: 341–353.

Mueller, J. F. 1937 Further studies on North American Gyrodactyloidea. Am. Midland Naturalist **18**: 207–219.

Price, E. W. 1938 North American monogenetic trematodes. 1. The superfamily Gyrodactyloidea. J. Washington Acad. Sci. **27**: 114–130 and 146–164.

Van Oosten, John. 1923 The whitefishes (*Coregonus clupeaformis*). A study of the scales of whitefishes of known ages. Zoologica **2**: 381–412.

Wotton, R. M., and R. L. Zwemer. 1935 A note on "glychrogel" mounting solution. Stain Technol. **10**: 21–22.

Explanation of Plate

All figures were made at the same magnification with the aid of a camera lucida.

Urocleidus grandis n. sp.

Fig. 1. Dorsal bar
Fig. 2. Ventral bar
Fig. 3. Dorsal anchor
Fig. 4. Ventral anchor
Fig. 5. Copulatory complex
Fig. 6. Hook (common type)
Fig. 7. Hook (of pair number five)

Urocleidus chaenobrytus n. sp.

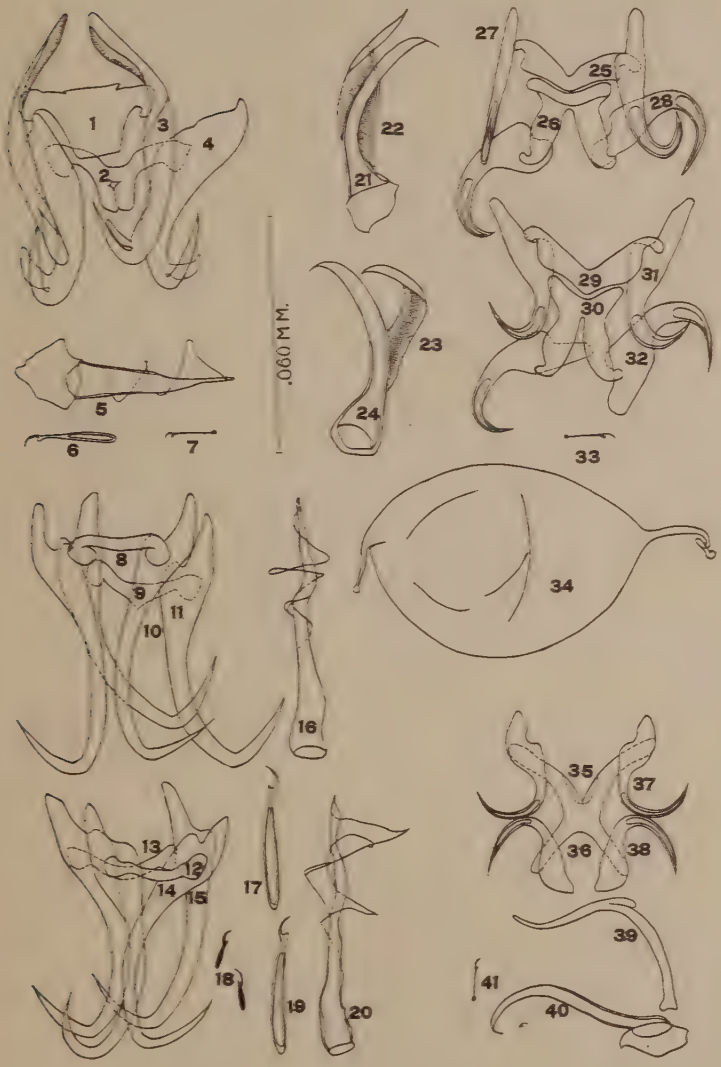
Figs. 8 & 12. Ventral bars
Figs. 9 & 13. Dorsal bars
Figs. 10 & 14. Ventral anchor
Figs. 11 & 15. Dorsal anchors
Figs. 16 & 20. Copulatory complexes
Figs. 17 & 19. Hooks (common type)
Fig. 18. Hooks (of pair number five)

Actinocleidus okeechobeensis n. sp.

Figs. 21 & 24. Cirri
Figs. 22 & 23. Accessory pieces
Figs. 25 & 29. Anterior bars
Figs. 26 & 30. Posterior bars
Figs. 27 & 31. Anterior anchors
Figs. 28 & 32. Posterior anchors
Fig. 33. Hook
Fig. 34. Egg

Actinocleidus flagellatus n. sp.

Fig. 35. Anterior bar
Fig. 36. Posterior bar
Fig. 37. Anterior anchor
Fig. 38. Posterior anchor
Fig. 39. Accessory piece
Fig. 40. Cirrus
Fig. 41. Hook


1
2
3
4
5
6
7
.060 M.M.
21
22
23
24
25
26
27
28
29
30
31
32
33
34
8
9
10
11
16
12
13
14
15
17
18
19
20
35
36
37
38
39
40
41

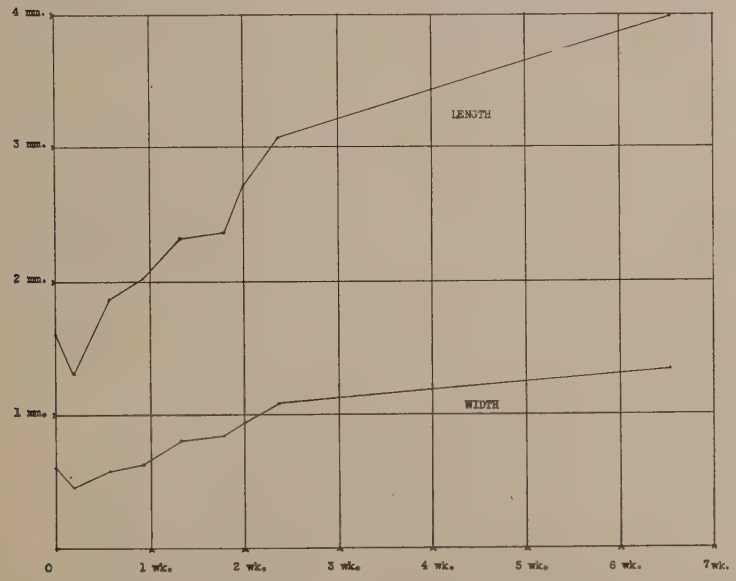
RESEARCH NOTES

OBSERVATIONS ON THE RATE OF GROWTH OF THE TREMATODE *POSTHARMOSTOMUM LARUEI* MCINTOSH 1934

During the course of recent investigations with the life cycle stages of the trematode, *Postharmostomum laruei* McIntosh 1934, occasion presented itself to study the rate of growth of the adult generation. The cercariaea were obtained from various species of land snails of the genera *Polygyra* and *Angiospira,* and were fed to laboratory mice. In some cases several different mice were fed larval flukes of the same brood source, taken from the same individual snail. In other cases many of the cercariaea from a number of snails were mixed together in a dish, after which they were fed to the mice in such a way that each host received a number of flukes. The mice were permitted to ingest as many of the cercariaea as they could take during the one experimental feeding, after which they were tagged with the date of feeding.

The mice were killed and examined at different periods of time. In this way various ages of the fluke were obtained, dating from the time of their introduction into the host. All flukes were killed with Hofer's killing reagent under pressure of a cover glass. Since the method of fixation was the same for all specimens, any noticeable size differences cannot be explained as the result of different methods of fixation.

Length and width measurements were made of a number of flukes of the same age. A growth curve was obtained by plotting the average measurements for each age of fluke (see Fig.). Unfortunately some of the mice were not heavily in-



fected, so that the measurements for some of the age levels are averages of only a few specimens. This is evident in the following table, which gives the data from which the curve was plotted.

A comparison of the different sizes of the flukes, when correlated with their ages

as shown on the graphs, brings to light several interesting points.

1. There is a decided decrease in the size of the parasite shortly after it is ingested by the host animal, since the cercariaeum before it is ingested measures 0.30 mm longer and 0.14 mm greater in width than does the fluke after it has been in the host 30 hours. This decrease in size was pronounced in all of the flukes of the 30-hour age, and is probably accountable on the basis that the parasite does not feed during its passage down the alimentary canal to its final site of infection, the cecum. A loss in weight, and therefore size, due to a loss of water content and a failure to feed during this passage is not only possible, but highly probable. A similar loss probably occurs in other digenetic flukes upon entering the bodies of their definitive hosts. Such a loss represents one more hazard encountered by a fluke in completing its life cycle. Just what it means in terms of mortality cannot be determined here. However, it seems evident that this represents a critical period in the life of a fluke, and when one considers the abrupt changes encountered by such a parasite in changing from a cold-blooded to a warm-blooded host, it is understandable how such a loss might occur. Other animals have died with less provocation. Not only must the trematode

TABLE 1.—*Growth measurements of* Postharmostomum laruei *in the laboratory mouse. See Fig.*

Age (Hours in host)	Average length	Average width	Number of flukes
	mm	*mm*	
0 ..... (Cercariaea)	1.60	0.60	27
30	1.30	0.46	15
96	1.87	0.57	17
156	2.02	0.62	7
220	2.32	0.81	9
300	2.37	0.85	4
336	2.71	0.94	18
400	3.07	1.09	28
1100	3.99	1.32	5

withstand a temperature change, which in some cases may be a change of some 40 degrees or more, but it must also be adapted to withstand the new chemical factors which are introduced by a change of host.

2. The curves show a gradual increase in both length and width between a 400 hour old fluke and one that is 1100 hours old. Unfortunately there are no readings recorded between these two age levels. Maturity is apparently reached by the time the fluke is 400 hours old, since flukes of that age have their uteri filled with eggs. Eggs were recovered from the feces of the mice at the end of the second week of infection.

3. The striking differences in size, as indicated in both the chart and graph, emphasize once more the undesirability of placing too much importance on size in diagnosing species differences. The differences in size between different ages of the same fluke, as shown here, are comparable to those which have been used, at times, as a basis for indicating different species. Undoubtedly many so-called "new species" which have been diagnosed as such on the basis of size are really younger or older specimens of some already described species.—JOE N. MILLER, *Ohio State University.*

IMMUNITY TO SUPERINFECTION WITH SPOROZOITES IN TWO STRAINS OF *PLASMODIUM CATHEMERIUM*

The existence of a strong immunity to superinfection with the homologous strains of *Plasmodium* is well known. For *P. cathemerium* such immunity has been demonstrated by Gingrich (1932, Am. J. Prev. Med. **6**: 197–246) and others. On the other hand, more recently, Boyd and Kitchen (1936, Am. J. Trop. Med **16**: 317–382) have reported that the mechanism of immunity to superinfection in *P. vivax* is directed against the trophozoites, but not against the sporozoites. Whether the

original infection was introduced by trophozoites or sporozoites apparently made no difference. So far as is known to the present authors, all the work on immunity to superinfection in avian *Plasmodium* has been done by using the method of blood inoculation, so that only immunity to superinfection with trophozoites has been demonstrated. For this reason, the present experiments were undertaken in order to determine whether or not, immunity to superinfection in the avian species is effective again the trophozoites but not against the sporozoites, as in human *Plasmodium.*

Two experimental canaries were inoculated by blood, one with the Wolfson strain of *P. cathemerium,* the other with the Hartman strain of this species. Two batches of *Culex* mosquitoes, each batch infected with one of the above strains, were maintained in the laboratory for about two weeks after their infective blood meals. Then one mosquito from each batch was dissected and sporozoites were found in its salivary glands. The thoraxes of the remaining mosquitoes were crushed in normal saline solution and the suspension was injected intramuscularly into two canaries carrying the homologous strains of *P. cathemerium.* The canary having the latent infection with the Wolfson strain was injected with sporozoites 110 days after its original inoculation, and two controls were used for it. The canary having the latent infection with the Hartman strain was injected with sporozoites 240 days after its original inoculation, and one control was used for it. Before the sporozoites were injected, the blood of the two experimental canaries was subinoculated into two previously uninfected birds, and the latent state of their infection was thus established with certainty. After the sporozoite inoculation, the blood films of all canaries were prepared, usually daily, for at least two weeks. The slides were studied with the oil immersion lens and the 10× ocular, and the number of parasites found in 50 of such microscopic fields was compared from day to day.

Neither of the experimental canaries showed any parasites at any time. The one inoculated with the Wolfson strain lived only one month after the sporozoite inoculation. When autopsied at death, no erythrocytic infection could be detected in its tissues, however, a few exoerythrocytic stages were found in its brain. in the two controls inoculated with sporozoites of the Wolfson strain, the number of parasites reached considerably above 1000 on the ninth day after the inoculation and both birds were dead on the tenth day. The control canary infected with the Hartman strain recovered after showing parasites for 10 days after inoculation. The number of parasites in this bird reached 90 at the peak of the infection.

To summarize, two canaries infected by blood with *P. cathemerium,* the Wolfson strain in one case, and the Hartman strain in another, were inoculated with sporozoites of the homologous strains 110 and 240 days, respectively, after their original inoculation. As a result, no parasites were observed in the two experimental birds, while the three controls developed infections which in case of the Wolfson strain were fatal. The present experiments indicate that in the two strains of *P. cathemerium,* unlike the human species, *P. vivax,* immunity to superinfection is probably effective against sporozoites as well as against trophozoites.—Fruma Wolfson and Ottis R. Causey, *Department of Protozoology, School of Hygiene and Public Health, Johns Hopkins University.*

BLOOD PARASITES OF CALIFORNIA BIRDS

The study of avian blood parasites in western birds has heretofore received little attention. This survey is an initial effort to expand our knowledge in this field and to correlate the incidence of infection of western birds with the already well-known surveys of eastern birds.

During the past year 150 birds, embracing 30 species, have been examined for blood parasites; of this number a total of 41, comprising 6 species, were found to be infected. Members of the genera *Plasmodium, Haemoproteus, Trypanosoma,* and a few microfilariae, were encountered.

PLASMODIUM

House finch.—Carpodacus mexicanus s. sp. The first record of infection with

Plasmodium in this bird was given by Plimmer, (1912, Proc. Zoöl. Soc. London 1: 2, 406–19), wherein he described as *P. praecox* Grassi and Feletti, a parasite of the finch, taken in Mexico. In our survey 22 birds from central California showed 7 infections with *P. praecox*, and 12 with *P. elongatum* Huff; from southern California 17 birds examined showed 3 infections with *P. praecox* and 2 with *P. elongatum*. This is the first record of *P. elongatum* from this finch.

Gambel sparrow.—Zonotrichia leucophrys gambeli. Thirteen birds examined from southern California showed 2 infections with *P. praecox* and 2 with *P. elongatum*. This is the first record of *P. elongatum* in this species.

Brewer blackbird.—Euphagus cyanocephalus. Examination of thirteen birds from southern California, showed 2 infections with *P. praecox*. This is the first time *P. praecox* has been recorded from this bird.

HAEMOPROTEUS

Mourning dove.—Zenaidura macroura s. sp. Four birds from northern California showed two infections, one with *H. maccallumi* Novy and MacNeal, and one with *H. sacharovi* Novy and MacNeal; from southern California 2 birds examined showed one infection with *H. maccallumi*.

TRYPANOSOMA

Audubon warbler.—Dendroica auduboni auduboni. Eleven birds examined from southern California showed one infection with a parasite similar to the one described by Wood and Wood (1937, J. Parasitol. **23**: 197–202).

Vermilion flycatcher.—Pyrocephalus rubinus mexicanus. Examination of one bird from southern California showed a light infection with a parasite similar to *T. avium* Novy and MacNeal.

MICROFILARIAE

House finch.—Caprodacus mexicanus s. sp. One heavy infection with microfilariae was encountered in a bird from southern California.

Audubon warbler.—Dendroica auduboni auduboni. Examination of 11 birds showed 3 infections with microfilariae.

The following birds showed no blood parasites: 8 California woodpeckers, *Melanerpes formicivorus bairdi;* 5 whitecrowned sparrows, *Zonotrichia leucophrys leucophrys;* 3 yellowbilled magpies, *Pica nuttali;* 3 wood ducks, *Aix sponsa;* 3 California jay, *Aphelocoma california;* 2 California shrikes, *Lanius ludevicianus;* 2 western crows, *Corvus brachyrhynchos caurinus;* 2 red-winged blackbirds, *Agelaius phoeniceus* s. sp.; 2 ash-throated flycatchers, *Myiarchus cinerascens cinerascens;* 2 barnswallows, *Hirundo erythrogaster;* 2 green-winged teals, *Nettion carolinensis;* 2 cliff swallows, *Petrochelidon lunifrons lunifrons;* 1 killdeer, *Oxyechus vociferus;* 1 meadow lark, *Sturnella neglecta;* 1 western grasshopper sparrow, *Ammodramus savannarum bimaculatus;* 1 English sparrow, *Passer domesticus;* 1 white-winged surf scoter, *Oidemia perspicillata;* shoveller duck, *Spatula clypeata;* avocet, *Recurvirostra americana;* sanderling, *Crocethia alba;* semipalmated plover, *Charadrius semipalmatus;* wren-tit, *Chamoea fasciata;* green back goldfinch, *Astragalinus psaltria hesperophilus.*

Conclusion. As a result of this survey the house finch and the Gambel sparrow are recorded as new hosts for *Plasmodium elongatum. Plasmodium praecox* is recorded for the first time from the brewer blackbird. The vermilion flycatcher was shown to harbor a trypanosome similar to *Trypanosoma avium.* Microfilariae were encountered in the house finch and audubon warbler.—W. B. Herms, C. G. Kadner, P. Galindo V. and D. F. Armstrong, *University of California and Loyola University of Los Angeles.*

REVIEWS

AN INTRODUCTION TO NEMATOLOGY. By B. G. Chitwood and M. B. Chitwood. Section I, Part II: pp. 55–123, figs. 54–111. Pub. by the authors, Babylon, N. Y. 1938. $3.00.

A continuation of Part I in style, form, and pagination, and dealing with the morphology of nematodes in detail sufficiently acute and so widely applied classificationally that the inclusion of "Introduction" in the title must seem out of place to many who are not professional nematologists. Chapters V to VIII, which comprise Part II, cover respectively the cephalic structures and stoma; the esophagus; the intestine; and the posterior gut. Since many variations in these structures are useful taxonomically and have been demonstrated to be tenable phylogenetic markers, the authors have developed these subjects, particularly that concerned with the esophagus, with great care. The inclusion by the authors of much comparative material should be of great assistance to anyone seriously interested in nematode morphology.

To many parasitologists it may be somewhat of a surprise to observe the extent to which the classical "free-living" and "parasitic" nematodes are morphologically interrelated. The sound zoological basis on which the authors have worked is commendable, and the excellent correlative study which results, together with the extensive chapter bibliographies, provide parasitologists for the first time an opportunity to see a familiar field in its relationship to that championed so long by the late N. A. Cobb.

Realizing that the publication of this work is a personal labor of love and not a commercial venture, it may seem out of place to offer criticism, yet certain points demand brief attention. Almost all of the figures are actually multi-figured plates with individual figures designated by letter. In the obvious effort to utilize space to the utmost, excessive crowding of these figures has sometimes resulted, thereby detracting from the individual illustrations. In balancing the figures to cover plates to the practicable limit, the key letters have become scattered to some extent over the plates, particularly those in the last two chapters. This makes it difficult in many instances to refer freely from the alphabetized legend to a particular figure without a disconcerting search. Considering the inherent difficulty of their subject, the authors have done well with form, but clearly and properly were more concerned with substance. Since it may be many years before a revision can be hoped for, this reviewer feels that the caution suggested in a review of Part I in this JOURNAL (Hall, 1937, **23**: 234) concerning "careful editing" may appropriately be repeated. A few errors obviously not typographical in nature are present: italicizing "trichostrongyloids" (p. 167), the consistent use of *"Dioctophyma,"* etc. (Several typographical corrections, mostly minor, are noted on p. 123 as applying to the previously published Part I.)

That differences of opinion with regard to classification may arise seems certain. Thus the authors state (p. 81) that "Members of the Ascarididae have only three esophageal gland nuclei and for that reason *Ascaridia,* with binucleate subventral glands, though the esophagus is cylindrical, must be placed in the Heterakidae." Such morphologically justifiable procedure ignores the fact that Eisenbrandt (1938) has reported *Ascaridia lineata* to be much more closely related serologically to *Ascaris suum* and *Toxocara canis* than it is to *Heterakis papillosa.* A clear point for debate is indicated.—G. L. GRAHAM.

AMERICAN ILLUSTRATED MEDICAL DICTIONARY. By W. A. Newman Dorland. 1607 pages, 942 illustrations including 283 portraits in text. W. B. Saunders Co., Philadelphia. 1938. 18th edition. $7.00 (thumb-indexed $7.50).

Among the specialized compendia which have appropriate place at the elbow of the professional parasitologist is the medical dictionary. Dorland's, first copyright in 1900 and now in its eighteenth edition, reaches over 1600 pages in a com-

pact, thumb-indexed volume with limp cover. Terms are printed in black face, with pronunciation and (usually) derivation indicated, as well as meaning; abbreviations are listed in alphabetical position. Numerous tables include: acids (11 pp.), cells (5 pp.), culture medium (2 pp.), diseases (6 pp.), laws (4 pp.), method (7 pp.), muscles (20 pp.), reactions (5 pp.), reagents (1 p.), solutions (3 pp.), stains and staining methods (11 pp.), tests (32 pp.), theories (2 pp.), and weights and measures (4 pp.). Among the illustrations are several colored plates, as for blood cells and malarial organisms.

Parasitological terms in Dorland's volume are of mixed value, containing many anachronisms. One is referred, for instance, to *Ankylostoma, Diendamoeba, Schistosomum,* instead of the correct *Ancylostoma, Dientamoeba, Schistosoma. Diphyllobothrium* is correctly listed under its own heading, but incorrectly under tapeworm. The tapeworm plate (p. 1405) carries such outmoded names as *Bothriocephalus latus, Taenia (Hymenolepis) nana, Taenia elliptica,* and *Taenia (Hymenolepis) solium. Triodontophorus* is in the "family Strongylides," *Haemonchus contortus* "infests the intestines of sheep and other ruminants in Argentine." Besides these errors—examples could be multiplied—the volume demonstrates the older variability in the use of infect and infest when referring to animal parasites, usage which the report of the Committee on Terminology of the American Society of Parasitologists has done so much to remove, with its status of infect for intra-host, infest for extra-host phases. The illustrations given suggest the advisability of a thorough-going revision of the terms concerning animal parasites.—Norman R. Stoll.

Parasitology. With special reference to man and domestic animals. By Robert Hegner, Francis M. Root, Donald L. Augustine, and Clay G. Huff. 812 pages, 308 illustrations. D. Appleton-Century Co., New York. 1938. 2nd edition. $7.00.

This book is a revision of "Animal Parasitology," by Hegner, Root and Augustine, published in 1929 (reviewed in this Journal, 1929, **15**: 294–295). Although the general plan of the work and the bulk of the material have remained the same as in the original edition, much of the new knowledge of parasitology acquired since 1929 has been included, and many small improvements in mode of presentation have been made. The introduction by Hegner consists of a brief discussion of parasitism, and provides a number of useful definitions. An interesting note on the protozoa of man and monkeys and their evolutionary significance is added to this section. There is also a valuable diagrammatic figure showing the localization of various protozoan, helminth, and insect parasites in or on the human body.

The book is divided into three main sections: Protozoology, by Hegner; Helminthology, by Augustine; Arthropods of Parasitological Importance, by Root and Huff. In each section, the various organisms which are discussed are grouped on the basis of their taxonomic position. The biology of each group is briefly described and the essential taxonomic information and keys are furnished. The life histories, occurrence, pathogenicity, control, etc., of those forms which parasitize man or domestic animals are treated in considerable detail. There are many lists, which should be helpful both to students and teachers, of the more common parasites and their hosts. A number of the illustrations of the original edition have been replaced by new ones. Some of these, such as the new figures showing the differences in attitude between anopheline and culicine larvae and pupae, are distinct improvements. Others, unfortunately, are not. Thus the drawings of several of the parasitic amoebae represent the ectoplasm of the pseudopodia as sharply cut off from the ectoplasm of the rest of the body.

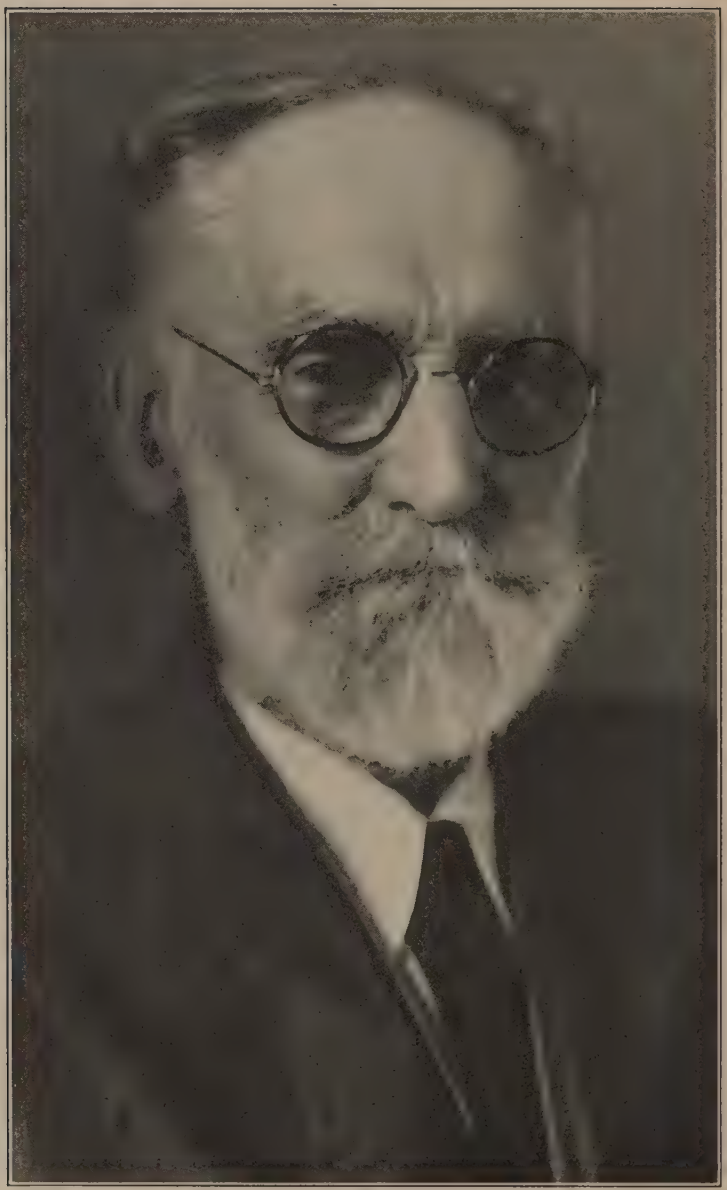
The book covers a wide field in a most efficient manner, but a few errors and omissions should be noted. In the section on protozoology, at one point a correct description is given, based on the work of Dobell and of Cleveland, of the excystation and subsequent nuclear and cytoplasmic divisions of *Endamoeba histolytica.* But in the immediately preceding paragraph (p. 55) the statement remains that

the excysted amoeba divides into four uninucleate amoebae. Although the chapter on trypanosomes does contain a brief note concerning their cultivation, no mention is made of the interesting and important work of the Lwoffs on the nutritional requirements of certain of these organisms. The chapter on intestinal flagellates gives no information concerning the cultivation of these forms, a field in which some progress has been made since 1929. In the discussion on malarial parasites, the old figures of Schaudinn showing penetration of a red cell by a sporozoite are included, whereas nothing is said about the extremely important recent discoveries concerned with the so-called extraerythrocytic stages. In the section on helminthology, some information concerning *Neoaplectana glaseri* and its cultivation might well have been given, since it is a form which may prove to be of economic importance and since it is the first parasitic nematode to be cultured in vitro. The change in title of the last section of the book from "Medical Entomology" to "Arthropods of Parasitological Importance" points accurately to the somewhat broader biological viewpoint adopted by Huff in revising this section. One error noted here is the statement that Blacklock and Gordon studied the acquired immunity of rats to larvae of *Cordylobia*. Actually, they worked with guinea pigs.

This new edition, like the original, closes with an extensive bibliography and two indices. It will undoubtedly be highly valued as a reference source as well as a rather readable outline of the subject of parasitology.—W. Trager.

A Guide to Human Parasitology. By D. B. Blacklock and T. Southwell. 259 pages, 2 colored plates and 122 illustrations. William Wood and Co., Baltimore. 1938. 3rd edition. $4.00.

The third edition of this text in parasitology, which is primarily intended for use by students in special courses and medical practitioners who have no laboratory at hand and must themselves make diagnoses of diseases caused by animal parasites, remains in much the same form as the previous edition. However, the chapter on malaria has been entirely rearranged into a form that the authors hope will facilitate study of the subject. The section on leishmaniasis is rewritten and together with the subject matter of the rest of the book has been brought up to date by inclusion of the more important of the latest advances in knowledge. The authors have purposely left out many details of taxonomy and morphology so that persons who are not trained parasitologists can grasp the essential characters by which parasites may be diagnosed without being confused by a mass of new names and anatomical information. Emphasis, as in previous editions, is put on pathogenic organisms and features usable for ready diagnosis of these forms throughout the world. For those generally interested in public health a series of summaries and tables show quickly those parasites which are encountered in food and water. A large number of diagrams, tables, synopses, and keys in the closing pages of the book put into orderly and workable schemes the varied information offered in the text and serve to make this book an admirable aid for the unspecialized worker.—M. S. Ferguson.



Cooper Curtice (1856–1939)

IN MEMORIAM

Cooper Curtice

1856–1939

Dr. Cooper Curtice was born in Stamford, Connecticut, on May 7, 1856. He received a B.S. degree from Cornell University in 1881, a degree in veterinary science from the Columbian Veterinary College in 1883, and a degree in medicine from the National Medical College, now the George Washington University, in 1888.

In 1883 he entered the service of the U. S. Geological Survey as scientific aid in paleontology. In 1886 he became an agent in the Federal Bureau of Animal Industry, from which position he resigned in 1891. From 1893 to 1894 he served as veterinarian to the State Board of Health of New York. He then returned to the Bureau in 1894, but remained only two years, resigned in 1896, and returned to New York where he again served as veterinarian to the State Board of Health from 1896 to 1897. He became state veterinarian of North Carolina in 1898 and served in that capacity until 1900, when he accepted a position with the Rhode Island Agricultural Experiment Station. In 1906 he resigned this position and returned to the Bureau of Animal Industry where he served continuously until his retirement in 1930.

Shortly after Dr. Curtice entered the Bureau in 1886, he began his work in parasitology with an investigation of tapeworms of sheep in Colorado. He found that the most common tapeworm of sheep in that area was the fringed tapeworm and determined some phases of its life history in the sheep. Although he did not determine the complete life history of this parasite, little has been added to Curtice's work since that time.

In 1889 Dr. Curtice ascertained the life history of the cattle fever tick, his findings being presented before the Washington Biological Society in February, 1890, and published in 1891. At that time he proposed for the cattle fever tick the generic name, *Boophilus*.

During the winter of 1888–1889 he discovered the cause of nodular disease in sheep, a condition commonly mistaken for tuberculosis because of the gross appearance of the lesions. While examining some of the lesions in the intestines of a sheep he found the larvae of the nematode which he later named *Oesophagostomum columbianum*, and which is generally known as the common nodular worm of sheep. In 1890 Dr. Curtice published the results of some observations on ox warbles. He discovered the ox warble larvae in the esophagus of cattle and postulated the probable life cycle of this parasite, which has been verified by subsequent investigators except as to the mode of entrance of the larvae into

the body. In the same year Dr. Curtice's "Animal Parasites of Sheep" was also published. In 1892 Dr. Curtice suggested that animals should be freed from ticks so far as possible as a means of controlling tick fever, and in 1896 a paper on the subject was presented before the Virginia State Veterinary Medical Association; in the paper he urged that the eradication of ticks be undertaken and outlined a program of tick eradiction. In 1899 he inaugurated a tick eradication campaign in North Carolina. This campaign was continued by Dr. Tait Butler and at the end of 1906 when the federal government began its tick eradication cam-

paign, twenty counties in North Carolina had been freed from cattle ticks.

In 1900 Dr. Curtice accepted a position at the Rhode Island Agricultural Experiment Station, remaining at this station for 6 years. During that time he conducted studies on blackhead that led to the important conclusion that chickens were the reservoir hosts of the organism causing this disease and that turkeys should be raised away from chickens and from areas ranged by chickens in order to protect them from blackhead. It was Cooper Curtice, therefore, who first established the principle of segregation as a measure of value for the control of this poultry disease.

In 1906 Dr. Curtice returned to the Bureau of Animal Industry and was put in charge of tick eradication work in Virginia and North Carolina where he worked until 1914. In that year the Zoological Division established a station at Vienna, Virginia, for the investigation of sheep

parasites, and Dr. Curtice was placed in charge. He remained in Vienna until 1925, when the work was transferred to McNeill, Mississippi, where he remained until his retirement in 1930.

Dr. Cooper Curtice's interest extended beyond the field of parasitology, in the strict sense of that word. He was but little concerned with the zoological and academic phases of the subject, but was intensely interested in its economic aspects. He was primarily a veterinarian interested in animal diseases caused by parasites and in the treatment, prevention and eradication of these diseases. Dr. Curtice's chief contribution to parasitology was undoubtedly his discovery of the life history of the cattle fever tick. This discovery, while interesting, would not have been of major importance except for the fact that this discovery enabled other workers in the Bureau of Animal Industry to demonstrate experimentally and beyond the peradventure of doubt, that the cattle tick, *Boophilus annulatus,* was the definitive host and transmitter of tick fever or piroplasmosis.

The idea that cattle ticks were in some way connected with the problem of tick fever was not new. It had been entertained for years; it had been argued, affirmed, denied, and doubted, but Dr. Curtice's determination of the life cycle of the ticks made it possible to settle the question once and for all. The fact that the discovery was more or less accidental in no way lessens Dr. Curtice's accomplishment. He realized the importance of his discovery and immediately urged that a series of experiments be undertaken to demonstrate that cattle ticks were the actual vectors of tick fever. He was unfortunately called away from Washington at a crucial time, but the experimental work was undertaken by Dr. Kilborne and carried to a successful conclusion by Smith and Kilborne.

Dr. Curtice's interest in the tick fever problem did not cease with the final conclusive demonstration that cattle ticks were concerned in the transmission of piroplasmosis. As previously stated, he began to advocate tick eradication and in 1896 prepared an important paper on this subject. According to the late Dr. U. G. Houck, this paper probably contained the first published statement of the possibility of tick eradication. Dr. Curtice incessantly preached tick eradication and in introducing Dr. Curtice during a lecture tour in Alabama, Representative Richard P. Hobson bestowed on him the richly deserved title of "father of tick eradication." The results of the tick eradication program are well known today and had Dr. Curtice made no other contribution to veterinary parasitology his name would still be blessed throughout the South.

Dr. Curtice was also a fruitful investigator in other fields. His studies on internal parasites of sheep at Vienna, Va., and at McNeill, Miss., resulted in improved methods of treatment for lambs infected with internal parasites, especially stomach worms. Other investigations

related to bovine tuberculosis, blackhead of turkeys and methods of raising chickens and turkeys for the prevention of disease assure Cooper Curtice his place in the front ranks of animal disease investigators.

In 1933 The American Veterinary Medical Association presented Dr. Curtice with a medal in recognition of his pioneer work in veterinary science, and particularly in recognition of his contribution to our knowledge of tick fever and of the role of the tick, *Boophilus annulatus,* as the vector of the causative organism, *Babesia bigemina.*

The death of Dr. Cooper Curtice on August 3, 1939, terminated a fruitful career characterized by practical contributions to the control of parasites and parasitic diseases of livestock. Although Dr. Curtice's work is known to but few of the present generation of parasitologists, he played an important role in veterinary parasitology a generation ago and must be counted as one of the pioneers among veterinary parasitologists.—G. Dikmans, *Bureau of Animal Industry, U. S. Department of Agriculture.*

INDEX FOR VOLUME 25, NOS. 1-6

(Index for December Supplement, 1939, begins page 529)

Acanthocephalan parasite of fish, note on life cycle of *Leptorhynchoides thecatus* ... 180
Acquired immunity to the tick *Dermacentor variabilis*, further observations on ... 137
Aedes, relation of size to sex in pupae of ... 448
ALICATA, JOSEPH E. Preliminary note on the life history of *Subulura brumpti*, a common cecal nematode of poultry in Hawaii ... 179
ALICATA, JOSEPH E. AND ELLEN CHANG. The life history of *Hymenolepis exigua*, a cestode of poultry in Hawaii ... 121
AMERICAN SOCIETY OF PARASITOLOGISTS:
Minutes of 14th annual business meeting, Dec. 29, 1938, Richmond, Va. ... 187
Preliminary announcement, 15th annual meeting, Columbus, O. ... 476
Program and abstracts, 15th annual meeting, Dec. 28–30, 1939, Columbus, Ohio ... December, 1939, Supplement
Anopheline eggs, a method for mounting ... 281
Anopheline resembling *A. crucians* ... 186
Anthelmintic, new, "Raigan" for taeniasis ... 183
ARMSTRONG, D. F. (see Herms, Kadner, Galindo and Armstrong) ... 511
AUGUSTINE, DONALD L. AND D. GARNET DAVEY. Observations on a natural infection with *Strongyloides* in the dog ... 117

BAKER, FRED C. The preparation of a relatively stable urease concentrate from blowfly larvae ... 280
BAKER, F. C. (see Robinson and Baker) ... 149
Balantidium coli from swine in culture ... 401
BEAHM, EDGAR H. AND CORNELIA M. DOWNS. Differential blood picture and total cell count on normal and trichina infected albino rats ... 405
BEAVER, PAUL C. The morphology and life history of *Petasiger nitidus* Linton, (Trematoda: Echinostomidae) ... 269
BEAVER, PAUL C. The morphology and life history of *Psilostomum ondatrae* Price, 1931 (Trematoda: Psilostomidae) ... 383
Behavior of four species of pleurolophocercous cercariae ... 343
BELLAMY, R. EDWARD. An anopheline from inland Georgia resembling the brackish-water race of *Anopheles crucians* ... 186
BENNETT, HARRY J. AND ARTHUR G. HUMES. Studies on the pre-cercarial development of *Stichorchis subtriquetrus* (Trematoda: Paramphistomidae) ... 223
BISHOPP, F. C. Portrait ... Frontispiece
BISHOPP, F. C. Some problems in medical and veterinary entomology ... 1
BLACKLOCK, D. B. AND T. SOUTHWELL. A guide to human parasitology (Review) ... 515
Blood alterations in typhlohepatitis of turkeys ... 157
Blood parasites of California birds ... 511
Blowfly larvae, preparation of a relatively stable urease concentrate from ... 280
BOND, FRANKLYN F. Myxosporidia from fishes of the genus *Esox* ... 377
Books and Monographs ... 93
Brachylaemus from the barred owl, a new species of ... 277
BRACKETT, STERLING. Two new species of strigeid cercariae in lymnaeid snails from the United States ... 263
BRACKETT, STERLING (see Cort, McMullen and Brackett) ... 19
Branchiobdellidae (Annelida) on crayfishes of Champaign county, Illinois ... 448
BRAND, THEODOR VON. Chemical and morphological observations upon the composition of *Macracanthorhynchus hirudinaceus* (Acanthocephala) ... 329

Brown, H. W. and A. J. Sheldon. A note on the prevalence of intestinal helminths in Orange county, North Carolina 445
Byrd, Elon E. and Robert L. Roudabush. *Leptophyllum ovalis* n. sp., a trematode from the brown watersnake 471

Cable, R. M. and N. C. Wheeler. Notes on three new species of cercariae belonging to the pleurolophocerca group 35
Cantrell, William. Relation of size to sex in pupae of *Aedes aegypti* (Linn.), *A. triseriatus* (Say) and *A. vexans* Meigen 448
Causey, Ottis R. (see Wolfson and Causey) 510
Cercariae of pleurolophocerca group 35
Cercariae, a comparative study on the behavior of four species of pleurolophocercous 343
Cercaria pseudoburti, n. sp., a strigeid cercaria from western Massachusetts.. 87
Chang, Ellen (see Alicata and Chang) 121
Changes in the concentration of urease during pupal development of the blowfly *Phormia regina* 455
Chitwood, B. G. and M. B. An introduction to nematology. Section I, Part II (Review) 513
Choanotaenia iola, a new tapeworm from the robin 203
Coatney, G. Robert and Martin D. Young. The effect of colchicine on bird malaria 446
Colchicine on bird malaria, effect of 446
Comparative efficiency of various technics for the diagnosis of protozoa and helminths in feces 241
Composition of *Macracanthorhynchus hirudinaceus* (Acanthocephala) 329
Cort, W. W., D. B. McMullen and Sterling Brackett. A study of larval trematode infections in *Helisoma campanulatum smithii* (Baker) in the Douglas Lake region, Michigan 19
Cuckler, Ashton C. *Rictularia onychomis* n. sp. (Nematoda: Thelaziidae) from the grasshopper mouse, *Onychomis leucogaster* (Weid) 431
Cuckler, Ashton C. and Edson Fichter. Gregarines from the crab, *Cancer productus* 184
Culbertson, James T. Prophylaxis of mice against experimental *Trypanosoma equiperdum* infection by the periodic administration of germanin .. 443
Culbertson, James T. The immunization of rats of different age groups against *Trypanosoma lewisi* by the administration of specific antiserum per os 181
Culbertson, James T. Transmission of resistance against *Trypanosoma lewisi* from a passively immunized mother rat to young nursing upon her 182
Curtice, Cooper (In memoriam) 516

Davey, D. Garnet (see Augustine and Davey) 117
Diasia podilymbi, correction for *Diasia podilymbae* 186
Dientamoeba fragilis, Studies on. III. Binary fission with special reference to nuclear division 43
Dikmans, G. Cooper Curtice (1856–1939) 516
Diorchis (Cestoda: Hymenolepididae), a new species from the canvasback .. 483
Diplodiscus temperatus Stafford, studies on the biology of 189
Dipylidium sexcoronatum, validity of 185
Dirofilaria immitis, survival and location of microfilariae in the dog 23
Dobrovolny, Charles G. The life history of *Plagioporus lepomis,* a new trematode from fishes 461
Dorland, W. A. Newman. American Illustrated Medical Dictionary (Review) 513
Downs, Cornelia M. (see Beahm and Downs) 405

Ecological studies on larval trematodes from western Massachusetts 309
Endamoeba blattae, the nucleic acid cycle in 441

Enterobius vermicularis, distribution of ova in household dust 173
Entomology, problems in medical and veterinary 1
Evans, Charles R. The Branchiobdellidae (Annelida) on crayfishes of Champaign county, Illinois 448

Faust, Ernest Carroll, Willi Sawitz, John Tobie, Vada Odom, Charles Peres, and David R. Lincicome. Comparative efficiency of various technics for the diagnosis of protozoa and helminths in feces 241
Fichter, Edson (see Cuckler and Fichter) 184
Fish, Frederic F. Observations on *Henneguya salminicola* Ward, a myxosporidian parasitic in Pacific salmon 169

Gabaldon, Arnoldo. A method for mounting anopheline eggs 281
Galindo V., P. (see Herms, Kadner, Galindo and Armstrong) 511
Gambrell, E. (see Travis, Goodwin and Gambrell) 278
Germanin prophylaxis of mice against *Trypanosoma equiperdum* 443
Giardia, five new species of 11
De Giusti, Dominic L. Preliminary note on the life cycle of *Leptorhynchoides thecatus,* an acanthocephalan parasite of fish 180
Gomphus spicatus Hagen (Odonata), a new intermediate host for *Prosthogonimus macrorchis* (Trematoda) 281
Goodchild, Chauncey G. *Cercaria donecerca* n. sp. (gorgoderid cercaria) from *Musculium partumeium* (Say) 1822 133
Goodwin, M. H., Jr. (see Travis, Goodwin and Gambrell) 278
Gorgoderid cercaria from *Musculium partumeium* 133
Gower, W. Carl. Infectivity of *Prosthogonimus macrorchis* Macy for the common ring-necked pheasant 447
Graham, George L. Studies on Strongyloides. V. Constitutional differences between a homogonic and a heterogonic line of *S. ratti* 365
Gregarines from the crab, *Cancer productus* 184

Halipegus eccentricus n. sp. found in the ears of frogs, life cycle of 207
Haptophrya virginiensis, protozoan parasite of pickerel frog 141
Harkema, Reinard. A new species of *Brachylaemus* from the barred owl ... 277
Harwood, Paul D. (see Underwood and Harwood) 23
Hegner, Robert, Francis M. Root, Donald L. Augustine and Clay G. Huff. Parasitology (Review) 514
Henneguya salminicola in Pacific salmon, observations on 169
Herber, Elmer C. Studies on the biology of the frog amphistome, *Diplodiscus temperatus* Stafford 189
Herms, W. B., C. G. Kadner, P. Galindo V. and D. F. Armstrong. Blood parasites of California birds 511
Hill, William C. The nematode *Skrjabingylus chitwoodorum* n. sp. from the skunk 475
History of the hookworm (uncinariasis) campaign in our southern United States 283
Hiyeda, Kentaro and Bunjiro Terada. A new anthelmintic "Raigan" for taeniasis 183
Hookworm campaign in our southern United States, early history of 283
Humes, Arthur G. (see Bennett and Humes) 223
Hymenolepis exigua, cestode of poultry in Hawaii, life history of 121

Immunity, acquired, to ticks 57
Immunity to superinfection with sporozoites in two strains of *Plasmodium cathemerium* 510
Immunization against *Trypanosoma lewisi* by administration of antiserum per os 181
Intestinal helminths in Orange county, North Carolina 445
Intracellular microörganism-like bodies in the tick, *Dermacentor variabilis* Say 233

JELLISON, WILLIAM L. *Opisodasys* Jordan, 1933, a genus of Siphonaptera 413
JOHNSON, E. P. AND C. J. LANGE. Blood alterations in typhlohepatitis of turkeys, with notes on the disease 157

KADNER, C. G. (see Herms, Kadner, Galindo and Armstrong) 511
KATZIN, LEONARD I. AND HAROLD KIRBY, JR. The relative weights of termites and their protozoa 444
KINGSCOTE, A. A. Removing air bubbles from the buccal capsules of bursate worms 442
KIRBY, HAROLD, JR. (see Katzin and Kirby) 444
KOLODNY, MAXWELL H. A method for the preservation of viable forms of *Trypanosoma cruzi* 282

LANGE, C. J. (see Johnson and Lange) 157
LAWLER, H. J. Demonstration of the life history of the nematode *Syphacia obvelata* (Rudolphi, 1802) 442
Leptophyllum ovalis n. sp., a trematode from the brown watersnake 471
Leucocytozoon smithi Laveran and Lucet (1905) in turkeys in southeastern United States 278
LEVINE, NORMAN D. Observations on *Balantidium coli* from swine in cultures 401
Life cycle of a fluke, *Halipegus eccentricus* n. sp., found in the ears of frogs .. 207
Life cycle of *Leptorhynchoides thecatus,* acanthocephalan parasite of fish, note on 180
Life history of *Hymenolepis exigua,* cestode of poultry in Hawaii 121
Life history of *Petasiger nitidus* Linton (Trematoda: Echinostomidae) 269
Life history of *Plagioporus lepomis,* a new trematode from fishes 461
Life history of *Psilostomum ondatrae* Price, 1931 (Trematoda: Psilostomidae) 383
Life history of *Subulura brumpti,* cecal nematode of poultry in Hawaii, note on 179
Life history of the nematode *Syphacia obvelata* (Rudolphi, 1802) 442
LINCICOME, DAVID R. A new tapeworm, *Choanotaenia iola,* from the robin ... 203
LINCICOME, DAVID R. (see Faust, Sawitz, Tobie, Odom, Peres and Lincicome) 241
LINTON, EDWIN. (In memoriam) 451
LONG, L. HELEN AND NELSON E. WIGGINS. A new species of *Diorchis* (Cestoda: Hymenolepididae) from the canvasback 483
Lophotaspis vallei (Trematoda: Aspidogastridae), studies on 83
Louse resistance in rats, relation of vitamin A to 425

MCMULLEN, D. B. (see Cort, McMullen and Brackett) 19
Macracanthorhynchus hirudinaceus, chemical and morphological observations upon the composition of 329
MACY, RALPH W. *Gomphus spicatus* Hagen (Odonata) a new intermediate host for *Prosthogonimus macrorchis* (Trematoda) 281
Maggot-infected wounds, enzyme urease and occurrence of ammonia in 149
Malaria oöcysts in living mosquitoes, staining 278
Malarias, avian, factors influencing the asexual periodicity of 95
MEGLITSCH, PAUL A. The nucleic acid cycle in *Endamoeba blattae* 441
Metacercaria of *Amphimerus elongatus* Gower (Trematoda: Opisthorchiidae) 491
MEYER, SAMUEL LEWIS. Description of *Haptophrya virginiensis,* a protozoan parasite of the pickerel frog, *Rana palustris* Le Conte 141
MILLER, JOE N. Observations on the rate of growth of the trematode *Posthharmistomum laruei* McIntosh, 1934 509
MILLER, MAX J. The intestinal protozoa of man in midwestern Canada 355
MIZELLE, JOHN D. AND AARON SEAMSTER. Studies on monogenetic trematodes. I. New species from the warmouth bass 501
MOHAN, B. N. (see Russell and Mohan) 278
MOORE, J. PERCY. Edwin Linton (1855–1939) 451
Morphology of *Balantidium kirbyi* n. sp. from the plathander 197

Myxosporidia from fishes of genus *Esox* 377
Myxosporidia from tide pool fishes of California 359
Myxosporidian parasitic in Pacific salmon, observations on *Henneguya salminicola* 169

Nematode *Skrjabingylus chitwoodorum* n. sp. from the skunk 475
New species described in this volume (1939):
Actinocleidus flagellatus Mizelle and Seamster 504
Actinocleidus okeechobeensis Mizelle and Seamster 504
Balantidium kirbyi Rodriguez 197
Brachylaemus mcintoshi Harkema 277
Cercaria amherstensis Rankin 312
Cercaria constrictovesica Cable and Wheeler 38
Cercaria donecerca Goodchild 133
Cercaria holthauseni Rankin 312
Cercaria merchanti Rankin 313
Cercaria obscuradena Brackett 266
Cercaria opacocorpa Cable and Wheeler 35
Cercaria pseudoburti Rankin 87
Cercaria riponi Brackett 263
Cercaria semicarinatae Cable and Wheeler 37
Choanotaenia iola Lincicome 203
Diorchis nyrocae Long and Wiggins 483
Giardia botauri Travis 11
Giardia floridae Travis 12
Giardia melospizae Travis 13
Giardia ondatrae Travis 14
Giardia sturnellae Travis 13
Halipegus eccentricus Thomas 207
Henneguya acuta Bond 378
Henneguya nigris Bond 378
Leptophyllum ovalis Byrd and Roudabush 471
Leptotheca compressa Noble 359
Leptotheca sphaerula Noble 359
Myxosoma cuneata Bond 379
Myxosoma muelleri Bond 379
Oochoristica oklahomensis Perry 487
Oochoristica whitentoni Steelman 479
Opisthorchis tonkae Wallace and Penner 437
Plagioporus lepomis Dobrovolny 461
Polymorphus marilis Van Cleave 131
Rictularia onychomis Cuckler 431
Skrjabingylus chitwoodorum Hill 475
Sphaeromyxa gibbonsia Noble 360
Sphaeromyxa ovula Noble 360
Tamerlania melospizae Penner 422
Tatria duodecacantha Olsen 495
Trilospora californica Noble 361
Urocleidus chaenobryttus Mizelle and Seamster 503
Urocleidus grandis Mizelle and Seamster 502
Noble, Elmer R. Myxosporidia from tide pool fishes of California 359
Nolan, M. O. and Lucy Reardon. Studies on oxyuriasis. XX. The distribution of the ova of *Enterobius vermicularis* in household dust 173

Odom, Vada (see Faust, Sawitz, Tobie, Odom, Peres and Lincicome) 241
Olsen, O. Wilford. *Diasia podilymbi*, correction for *Diasia podilymbae* Olsen, 1938 186

Olsen, O. Wilford. Schizotaeniasis in muskrats 279
Olsen, O. Wilford. *Tatria duodecacantha,* a new species of cestode (Ambiliidae Braun, 1900) from the pied-billed grebe (*Podilymbus podiceps podiceps* (Linn.)) 495
Oochoristica whitentoni, a new anoplocephalid cestode from the land tortoise 475
Opisodasys Jordan, 1933 (Siphonaptera) 413
Opisthorchis, a new liver fluke of the genus 437
Oxyuriasis, studies on. XX. Distribution of ova in household dust 173

Parasitic lesions in turtles 395
Peery, Harold J. A new unarmed tapeworm from the spotted skunk 487
Penner, Lawrence R. *Tamerlania melospizae* n. sp. (Trematoda: Eucotylidae) with notes on the genus 421
Penner, Lawrence R. (see Wallace and Penner) 437
Peres, Charles (see Faust, Sawitz, Tobie, Odom, Peres and Lincicome) 241
Periodicity of avian malarias, factors influencing the asexual 95
Phormia regina, changes in the concentration of urease during pupal development of the blowfly 455
Pleurolophocerca group, cercariae belonging to 35
Postharmistomum laruei McIntosh, 1934, observations on the rate of growth of the trematode 509
Profilicollis, notes on status of 129
Prosthogonimus macrorchis, infectivity for pheasant 447
Prosthogonimus macrorchis (Trematoda), a new intermediate host for 281
Protozoa, intestinal, of man in midwestern Canada 355
Psilostomum ondatrae, the morphology and life history of 383
Psorophora (*Janthinosoma*) *horrida* Dyar and Knab, the larva of 145

Raigan, a new anthelmintic for taeniasis 183
Rankin, John S., Jr. *Cercaria pseudoburti* n. sp., a strigeid cercaria from western Massachusetts 87
Rankin, John S., Jr. Ecological studies on larval trematodes from western Massachusetts 309
Reardon, Lucy (see Nolan and Reardon) 173
Removing air bubbles from the buccal capsules of bursate worms 442
Rictularia onychomis n. sp. (Nematoda: Thelaziidae) from the grasshopper mouse 431
Robinson, W. and F. C. Baker. The enzyme urease and the occurrence of ammonia in maggot-infected wounds 149
Robinson, W. and C. S. Wilson. Changes in the concentration of urease during pupal development of the blowfly *Phormia regina* 455
Rodriguez, J. Manuel. On the morphology of *Balantidium kirbyi* n. sp. from the plathander 197
Roudabush, Robert L. (see Byrd and Roudabush) 471
Rozeboom, L. E. The larva of *Psorophora* (*Janthinosoma*) *horrida* Dyar and Knab (Diptera: Culicidae) 145
Russell, P. F. and B. N. Mohan. Staining malaria oocysts in living mosquitoes 278

Sawitz, Willi (see Faust, Sawitz, Tobie, Odom, Peres and Lincicome) 241
Schizotaeniasis in muskrats 279
Seamster, Aaron (see Mizelle and Seamster) 501
Searls, Ed. M. and Fred M. Snyder. A study of the relation of vitamin A to louse resistance in rats 425
Sheldon, A. J. (see Brown and Sheldon) 445
Snails as intermediate hosts of acanthocephala 443
Snyder, Fred M. (see Searls and Snyder) 425

STAUBER, LESLIE A. Factors influencing the asexual periodicity of avian malarias ... 95
STEELMAN, GERALD M. *Oochoristica whitentoni,* a new anoplocephalid cestode from the land tortoise ... 475
STEWART, M. A. The validity of *Dipylidium sexcoronatum* von Ratz, 1900 (Cestoda) ... 185
Stichorchis subtriquetrus (Trematoda: Paramphistomidae), studies on the precercarial development of ... 223
STILES, CHARLES WARDELL. Early history, in part esoteric, of the hookworm (uncinariasis) campaign in our southern United States ... 283
Strigeid cercariae in lymnaeid snails ... 263
Strongyloides in the dog, natural infection with ... 117
Strongyloides, Studies on. V. Constitutional differences between a homogonic and a heterogonic line of *S. ratti* ... 365
Subulura brumpti, note on life history of ... 179

Tamerlania melospizae n. sp. (Trematoda: Eucotylidae) with notes on the genus 421
Tapeworm from the spotted skunk, a new unarmed ... 487
Tatria duodecacantha, a new cestode from the pied-billed grebe ... 495
Termites and their protozoa, relative weights of ... 444
TERADA, BUNJIRO (see Hiyeda and Terada) ... 183
THOMAS, LYELL J. Life cycle of a fluke, *Halipegus eccentricus* n. sp., found in the ears of frogs ... 207
Ticks, acquired immunity to ... 57
TOBIE, JOHN (see Faust, Sawitz, Tobie, Odom, Peres and Lincicome) ... 241
TRAGER, WILLIAM. Acquired immunity to ticks ... 57
TRAGER, WILLIAM. Further observations on acquired immunity to the tick *Dermacentor variabilis* Say ... 137
TRAGER, WILLIAM. Intracellular microörganism-like bodies in the tick, *Dermacentor variabilis* Say ... 233
Transmission of resistance against *Trypanosoma lewisi* ... 182
TRAVIS, BERNARD V. Descriptions of five new species of flagellate protozoa of the genus *Giardia* ... 11
TRAVIS, BERNARD V., M. H. GOODWIN, JR. AND E. GAMBRELL. Preliminary note on the occurrence of *Leucocytozoon smithi* Laveran and Lucet (1905) in turkeys in the southeastern United States ... 278
Trematode, larval, infections in Douglas Lake region ... 19
Trematodes from western Massachusetts, ecological studies on larval ... 309
Trematodes, Studies on monogenetic. I. New species from the warmouth bass 501
Trichina infected albino rats, blood picture of ... 405
Trypanosoma cruzi, a method for preservation of viable forms of ... 282
Typhlohepatitis of turkeys, blood alterations in ... 157

UNDERWOOD, PAUL C. AND PAUL D. HARWOOD. Survival and location of the microfilariae of *Dirofilaria immitis* in the dog ... 23
Uncinariasis, early history of the hookworm campaign in our southern United States ... 283
Urease concentrate from blowfly larvae, preparation of ... 280

VAN CLEAVE, HARLEY JONES. A new species of the acanthocephalan genus *Polymorphus* and notes on the status of the name *Profilicollis* ... 129
Vitamin A and louse resistance in rats ... 425

WALLACE, F. G. The metacercaria of *Amphimerus elongatus* Gower (Trematoda: Opisthorchiidae) ... 491
WALLACE, F. G. AND LAWRENCE R. PENNER. A new liver fluke of the genus *Opisthorchis* ... 437

WENRICH, D. H. Studies on *Dientamoeba fragilis* (Protozoa). III. Binary fission with special reference to nuclear division 43
WHARTON, G. W. Studies on *Lophotaspis vallei* (Stossich, 1899) (Trematoda: Aspidogastridae) 83
WHEELER, NORMAN C. A comparative study on the behavior of four species of pleurolophocercous cercariae 343
WHEELER, N. C. (see Cable and Wheeler) 35
WHITLOCK, S. C. Snails as intermediate hosts of acanthocephala 443
WIECZOROWSKI, ELSIE. Parasitic lesions in turtles 395
WIGGINS, NELSON E. (see Long and Wiggins) 483
WILSON, C. S. (see Robinson and Wilson) 455
WOLFSON, FRUMA AND OTTIS R. CAUSEY. Immunity to superinfection with sporozoites in two strains of *Plasmodium cathemerium* 510

YOUNG, MARTIN D. (see Coatney and Young) 446

INDEX FOR DECEMBER SUPPLEMENT, 1939

(* refers to abstract number rather than page)

Acanthocephala, glycogen distribution in the body of 48*
Acanthocephala, systems for designating hook pattern in 7*
Acanthocephalan Family Rhadinorhynchidae, a reconsideration of 8*
Actual state of human hepatic distomosis in Cuba 87*
Age of rat, effect of, on the size of *Trichinella* infections 51*
Age resistance to *Strongyloides ratti* 71*
Allison, Leonard (See McMullen, Rezin and Allison) 54*
Ameel, Donald J. Observations on the life cycle of *Nudacotyle novicia* Barker, 1916 (Trematoda: Notocotylidae) 15*
American Society of Parasitologists:
List of members 40
Officers 37
Program, 15th Annual Meeting, Columbus, Ohio 1
Amoebae, intestinal, some unusual variations in cystic stages of 20*
Ancylostoma caninum, reaction between larvae and immune serum 68*
Anopheles quadrimaculatus, a study of winter activities and hibernation of, in the Tennessee valley 26*
Anthelmintic efficacy of unconditioned crude phenothiazine 89*
AUTHOR INDEX 7
Avian malarial oöcysts, quantitative studies on 21*

Baker, D. W. and W. S. Monlux *Hypoderma* myiasis in the horse, summary of a series of cases studied during spring and summer, 1939 ..... 25*
Basnuevo, José G. (see Kourí and Basnuevo) 87*
Beaver, Paul C. The life cycle of *Euparyphium melis* (Trematoda: Echinostomidae) 35*
Bennett, Harry J. and Arthur G. Humes The life history of *Stichorchis subtriquetrus* (Trematoda: Paramphistomidae) 33*
Blood picture of white mice infected with *Trichinella spiralis* 79*
Bovine blood picture in hookworm (*Bunostomum phlebotomum*) and nodular worm (*Oesophagostomum radiatum*) infections 88*
Brackett, F. S. (see Cole and Brackett) 44*
Brackett, Sterling (see Cort, McMullen, Olivier and Brackett) 2*
Branchiobdellids, geographical distribution in North America 10*
Brand, Theodor von. The glycogen distribution in the body of Acanthocephala 48*
Bunostomum phlebotomum, immunity to, in calves 74*
Bunostomum phlebotomum, studies on the blood picture in bovine infections 88*
Burrowing owl as a host to the argasid tick, *Ornithodoros parkeri* 30*

Cable, R. M. and A. V. Hunninen The life history of *Spelotrema nicolli* (Trematoda: Microphallidae) 50*
Caecincola parvulus (Trematoda: Heterophyidae), life history of 63*
Capillaria infection of the lower digestive tract of the common fowl (*Gallus domesticus*) 86*
Cercariae, strigeid, two new species of, from Michigan 1*
Cercariaeum mutabile (Cort): Trematoda, development of the excretory system in 62*
Cercarial survey of the Lake Okoboji region of Iowa 11*
Changes occurring in blood of chickens during cecal coccidiosis 84*
Clinostomum, studies on. VI. The penetration and post-cercarial development of *Clinostomum marginatum* (Rud.) 36*
Coatney, G. Robert (see Young, Coatney and Stubbs) 22*

(* refers to abstract number rather than page)

Coccidiosis, avian, the effect of sulfapyridine on ... 85*
Coccidiosis, cecal, changes occurring in blood of chickens ... 84*
Cole, Peter A. and F. S. Brackett Demonstration of ultraviolet microscopy 44*
Control of trichinosis, a practical plan for ... 81*
Corallobothrium sp. from *Ameiurus nebulosus,* life cycle of ... 37*
Cornucopula nassicola (Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae), life cycle of ... 13*
Cort, W. W., D. B. McMullen, Louis Olivier and Sterling Brackett The larval stages of the gull strigeid, *Diplostomum flexicaudum,* in juveniles and adults of *Stagnicola emarginata angulata* ... 2*
Cotylocercous cercariae, seasonal variation in emergence of ... 55*
Crawford, Wiley W. Studies on the life history of Colorado trematodes ... 60*
Culbertson, James T. and Harry M. Rose Allergic skin reactions in human *Echinococcus* infection with antigens from related taenias ... 72*
Cultivation of *Endamoeba histolytica* without serum ... 18*
Cultivation of *Nyctotherus cordiformis,* a new cultivation medium for ... 17*
Cysticercus pisiformis in rabbits, the intestinal phase of immunity to ... 73*

DeCoursey, J. D. (see Kudo and DeCoursey) ... 29*
DeGiusti, D. L. Further studies on the life cycle of *Leptorhyncoides thecatus* 45*
Delaune, Elaine T. and Roy L. Mayhew Studies on the bovine blood picture in hookworm (*Bunostomum phlebotomum*) and nodular worm (*Oesophagostomum radiatum*) infections ... 88*
Development of trematode metacercariae into adult worms in sterile cultures 16*
Digenetic trematodes of fishes of the Galapagos Islands and their relationships 56*
Dioctophyme renale, the giant kidney worm occurring in mink, from the southern counties of Michigan ... 50*
Dipetalonema diacantha, the development of, in mosquitoes ... 23*
Diplostomum flexicaudum, larval stages of, in *Stagnicola emarginata angulata* 2*
Diplostomum fosteri n. sp. from a Panama otter, *Lutra repanda* Goldman ... 57*
Dirofilaria spinosa, the development of, in mosquitoes ... 23*
Distomosis, human hepatic, actual state of, in Cuba ... 87*
Dobrovolny, Charles G. Seasonal variation in emergence of cotylocercous cercariae ... 55*
Downing, Vincent (see McCoy and Downing) ... 80*

Echinococcus, skin reactions in human infection ... 72*
Endamoeba histolytica, a method of obtaining clean suspensions of cysts from culture ... 41*
Endamoeba histolytica, cultivation of, without serum ... 18*
Endamoeba histolytica, microisolation of, and its cultivation with single species of bacteria ... 19*
Enterobius vermicularis, studies on the survival of eggs under known conditions of humidity and temperature ... 78*
Enterobius vermicularis, the effects of ultraviolet radiation on eggs of ... 43*
Euparyphium melis (Trematoda: Echinostomidae), life cycle of ... 35*
Excretory system in *Cercariaeum mutabile* (Cort): Trematoda, development of ... 62*
Excretory system in digenetic trematodes, development of ... 4*

Faust, Ernest Carroll A new record of human heartworm infection, from New Orleans ... 77*
Ferguson, Malcolm S. Development of trematode metacercariae into adult worms in sterile cultures ... 16*

Geographical distribution of North American Branchiobdellids ... 10*
Glugea microspora, a new microsporidian species from the liver of the sand-eel, *Amnodytes lanceolatus* ... 42*

(* refers to abstract number rather than page)

Glycogen distribution in the body of Acanthocephala 48*
Goldstein, Fred (see Mueller and Goldstein) 76*
Goodnight, Clarence J. Geographical distribution of North American Branchiobdellids 10*
Graham, George L. Length of life of singly-established *Strongyloides ratti* 70*
Groupé, Vincent (see Hunter and Groupé) 79*
Gursch, O. F. Sex ratio of *Trichinella spiralis* from the digestive tract of rats 52*
Gustafson, Paul V. Life cycle studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae) 14*

Habermann, Robert T. and Paul D. Harwood Anthelmintic efficacy of unconditioned crude phenothiazine 89*
Habermann, Robert T. (see Harwood, Habermann and Swanson) 83*
Harwood, Paul D., Robert T. Habermann and Leonard E. Swanson Phenothiazine as an anthelmintic 83*
Harwood, Paul D. (see Habermann and Harwood) 89*
Heartworm, a new record of human infection, from New Orleans 77*
Herber, Elmer C. Life history studies on monostomes of the genus *Notocotylus* (Trematoda) 34*
Herrick, C. A. Changes occurring in blood of chickens during cecal coccidiosis 84*
Hewitt, Redginal Segmentation in the internal organs in infections with a Mexican strain of *Plasmodium relictum* 28*
Highby, Paul R. The development of *Dipetalonema diacantha* and *Dirofilaria spinosa* in mosquitoes 23*
Hinman, E. Harold and H. S. Hurlbut A study of winter activities and hibernation of *Anopheles quadrimaculatus* in the Tennessee valley 26*
Hollaender, Alexander (see Jones, Jacobs and Hollaender) 43*
Hookworm, *Ancylostoma caninum,* reaction between larvae and immune serum 68*
Huff, Clay G. Quantitative studies on avian malarial oöcysts 21*
Humes, Arthur G. (see Bennett and Humes) 33*
Hunninen, A. V. (see Cable and Hunninen) 59*
Hunter, George W., III and Vincent Groupé The blood picture of white mice infected with *Trichinella spiralis* 79*
Hunter, George W., III, Wanda S. Hunter and Emil Kotcher Studies on *Clinostomum.* VI. The penetration and post-cercarial development of *Clinostomum marginatum* (Rud.) 36*
Hunter, Wanda S. (See Hunter, Hunter and Kotcher) 36*
Hurlbut, H. S. (see Hinman and Hurlbut) 26*
Hussey, Kathleen L. Development of the excretory system in digenetic trematodes 4*
Hypoderma myiasis in the horse, summary of a series of cases studied during spring and summer, 1939 ..... 25*

Immunity to *Cysticercus pisiformis* in rabbits, the intestinal phase of 73*
Immunity to hookworm (*Bunostomum phlebotomum*) and nodular worm (*Oesophagostomum radiatum*) infection in calves 74*
Immunity to *Trichinella spiralis,* transmission of, from parent to offspring .. 69*
Immunization of birds to malaria by vaccination 66*

Jacobs, Leon (see Jones and Jacobs) 78*
Jacobs, Leon (see Jones, Jacobs and Hollaender) 43*
Jellison, William L. The burrowing owl as a host to the argasid tick, *Ornithodoros parkeri* 30*
Jones, Myrna F., Leon Jacobs and Alexander Hollaender The effects of monochromatic ultraviolet radiation on eggs of *Enterobius vermicularis* . 43*

(* refers to abstract number rather than page)

JONES, MYRNA F. AND LEON JACOBS Studies on the survival of eggs of *Enterobius vermicularis* under known conditions of humidity and temperature 78*

Kiricephalus coarctatus (Diesing) Sambon, 1910, anatomy of 46*
KOHLS, GLEN M. Siphonaptera: A study of the species infesting wild hares and rabbits of North America north of Mexico 31*
KOTCHER, EMIL (see Hunter, Hunter and Kotcher) 36*
KOURÍ, PEDRO AND JOSÉ G. BASNUEVO Actual state of human hepatic distomosis in Cuba 87*
KUDO, R. R. AND J. D. DECOURSEY On the development of *Nosema bombycis* in the fall webworm, *Hyphantria cunea* 29*

LARSH, JOHN E., JR. Life cycle of *Corallobothrium* sp. from *Ameiurus nebulosus* 37*
Larval stages of the gull strigeid, *Diplostomum flexicaudum,* in juveniles and adults of *Stagnicola emarginata angulata* 2*
LAWLER, HARRY J. On the nature of age resistance to *Strongyloides ratti* ... 71*
Leeches (Piscicolidae) living on fresh-water fishes of North America, notes on 9*
LEIGH, W. HENRY Variation in a new cestode of the genus *Raillietina* (*Skrjabinia*) from the prairie chicken 6*
Length of life of singly-established *Strongyloides ratti* 70*
LEONARD, A. BYRON AND ALICE E. SMITH The intestinal phase of the immunity to *Cysticercus pisiformis* in rabbits 73*
Leptorhyncoides thecatus, further studies on the life cycle of 45*
Lernaea carassii, studies on the life history of 49*
Leucochloridium carus, experimental infection of European starling with 58*
LEVIN, ARTHUR J. Recovery of *Trichinella spiralis* larvae from early stages of infection 53*
LEVINE, P. P. The effect of sulfapyridine on experimental avian coccidiosis 85*
Life cycle of a cestode of the mouse, *Mus musculus,* preliminary investigations on 38*
Life cycle of *Corallobothrium* sp. from *Ameiurus nebulosus* 37*
Life cycle of *Cornucopula nassicola* (Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae) 13*
Life cycle of a cestode from the herring gull, further studies on 39*
Life cycle of *Euparyphium melis* (Trematoda: Echinostomidae) 35*
Life cycle of *Leptorhyncoides thecatus,* further studies on 45*
Life cycle of *Monorcheides cumingiae* (Martin) (Trematoda: Monorchidae). 32*
Life cycle of *Nudacotyle novicia* Barker, 1916 (Trematoda: Notocotylidae), observations on 15*
Life cycle studies on *Spinitectus gracilis* and *Rhabdochona* sp. (Nematoda: Thelaziidae) 14*
Life history of an apharyngeal strigeid trematode from Douglas Lake, Michigan 65*
Life history of a parasitic copepod, *Lernaea carassii,* studies on 49*
Life history of *Caecincola parvulus* Marshall and Gilbert (Trematoda: Heterophyidae) 63*
Life history of Colorado trematodes, studies on 60*
Life history of *Spelotrema nicolli* (Trematoda: Microphallidae) 59*
Life history of *Spirorchis* sp. (Trematoda: Spirorchidae) 64*
Life history of *Stichorchis subtriquetrus* (Trematoda: Paramphistomidae) .. 33*
Life history of *Triganodistomum mutabile* (Cort): Trematoda 61*
Life history studies and the development of parasitology 40*
Life history studies on monostomes of the Genus *Notocotylus* (Trematoda) .. 34*
LINCICOME, DAVID R. (see Van Cleave and Lincicome) 8*

(* refers to abstract number rather than page)

Linguatulid, *Kiricephalus coarctatus* (Diesing) Sambon, 1910, the anatomy of 46*
LUNDAHL, WALTER S. Life history of *Caecincola parvulus* Marshall and Gilbert (Trematoda: Heterophyidae) ... 63*

Malaria, immunization of birds by vaccination ... 66*
Malaria, quartan, in negro paretics, studies on ... 22*
Malarial oöcysts, avian, quantitative studies on ... 21*
MANTER, HAROLD W. Digenetic trematodes of fishes of the Galapagos Islands and their relationships ... 56*
MARCHANT, E. H. Effect of age of rat on the size of *Trichinella* infections .. 51*
MARTIN, W. E. The life cycle of *Monorcheides cumingiae* (Martin) (Trematoda: Monorchidae) ... 32*
MAUSS, EVELYN ABRAMS On the transmission of immunity to *Trichinella spiralis* from parent to offspring ... 69*
MAYHEW, ROY L. Immunity to hookworm (*Bunostomum phlebotomum*) and nodular worm (*Oesophagostomum radiatum*) infection in calves ... 74*
MAYHEW, ROY L. (see Delaune and Mayhew) ... 88*
McCOY, O. R. AND VINCENT DOWNING The penetration of radioactive phosphorus into encysted *Trichinella* larvae ... 80*
McINTOSH, ALLEN *Diplostomum fosteri* n. sp. from a Panama otter, *Lutra repanda* Goldman ... 57*
McINTOSH, ALLEN AND GERTRUDE E. McINTOSH Experimental infection of European starling with *Leucochloridium carus* ... 58*
McINTOSH, GERTRUDE E. (see McIntosh and McIntosh) ... 58*
McMULLEN, DONALD B., PAUL F. REZIN AND LEONARD ALLISON Schistosome dermatitis: distribution and epidemiology in Michigan ... 54*
McMULLEN, DONALD B. (see Cort, McMullen, Olivier and Brackett) ... 2*
McNEIL, CHARLES W. (see Woodhead and McNeil) ... 50*
MELENEY, HENRY E. AND THOMAS L. SNYDER A method of obtaining clean suspensions of cysts of *Endamoeba histolytica* from culture ... 41*
MEMBERSHIP ROSTER, AMERICAN SOCIETY OF PARASITOLOGISTS ... 40
Metacercariae, development into adult worms in sterile cultures ... 16*
MEYER, MARVIN C. Demonstration of a species of marine Piscicolidae from Florida ... 47*
MEYER, MARVIN C. Notes on the leeches (Piscicolidae) living on freshwater fishes of North America ... 9*
Microisolation of *Endamoeba histolytica* and its cultivation with single species of bacteria ... 19*
MILLER, E. L. A cercarial survey of the Lake Okoboji region of Iowa ... 11*
MIZELLE, JOHN D. Studies on monogenetic trematodes. III. Redescriptions and variations in a few known species ... 12*
MONLUX, W. S. (see Baker and Monlux) ... 25*
Monogenetic trematodes, studies on, III. Redescriptions and variations in a few known species ... 12*
Monorcheides cumingiae (Martin) (Trematoda: Monorchidae) life cycle of . 32*
MOREHOUSE, NEAL F. *Capillaria* infection of the lower digestive tract of the common fowl (*Gallus domesticus*) ... 86*
MUELLER, JUSTUS F. AND FRED GOLDSTEIN Experimental human infection with *Sparganum mansonoides* (Mueller, 1935) ... 76*
Myiasis, *Hypoderma,* in the horse ... 25*

NELSON, E. CLIFFORD A new cultivation medium and its use in the cultivation of *Nyctotherus cordiformis* ... 17*
NELSON, T. C. A practical plan for the control of trichinosis ... 81*
Nosema bombycis, development in the fall webworm, *Hyphantria cunea* ... 29*

(* refers to abstract number rather than page)

Notocotylus (Trematoda), life history studies on 34*
Nudacotyle novicia Barker, 1916 (Trematoda: Notocotylidae), observations on the life cycle of 15*
Nyctotherus cordiformis, a new cultivation medium for 17*

Oesophagostomum radiatum, immunity to in calves 74*
Oesophagostomum radiatum, studies on the blood picture in bovine infections 88*
Officers, American Society of Parasitologists 37
OLIVIER, LOUIS Two new species of unusual strigeid cercariae from the Douglas Lake region, Michigan 1*
OLIVIER, LOUIS The life history of an apharyngeal strigeid trematode from Douglas Lake, Michigan 65*
OLIVIER, LOUIS (see Cort, McMullen, Olivier and Brackett) 2*
Opisthorchioidea, review of 5*
Ornithodoros parkeri, from the burrowing owl 30*
Ornithodoros spp. in Arizona bat "caves" 24*
OTTO, G. F. The reaction between hookworm, *Ancylostoma caninum*, larvae and immune serum 68*

Pasture rotation and the prevalence of the helminth parasites of sheep in southwest Virginia, progress report on 82*
PENNER, LAWRENCE R. Experimental studies on *Schistosomatium douthitti* (Cort) in mouse, rat, muskrat, guinea pig, and snow-shoe hare 3*
Phenothiazine, anthelmintic efficacy of 89*
Phenothiazine as an anthelmintic 83*
PHILIP, CORNELIUS B. Ticks (*Ornithodoros* spp.) in Arizona bat "caves" 24*
PHILIP, CORNELIUS B. How Rocky Mountain spotted fever vaccine is prepared and used 27*
Piscicolidae, demonstration of a marine species from Florida 47*
Piscicolidae living on fresh-water fishes of North America 9*
Plasmodium lophurae, protective action of immune serum in chickens 67*
Plasmodium relictum, segmentation in the internal organs 28*
PRICE, EMMETT W. A review of the trematode superfamily Opisthorchioidea 5*
Protective action of immune serum against *Plasmodium lophurae* in chickens 67*

Radioactive phosphorus, penetration of, into encysted *Trichinella* larvae 80*
Raillietina (*Skrjabinia*), variation in a new cestode of the genus 6*
RANKIN, JOHN S., JR. The life cycle of *Cornucopula nassicola* (Cable and Hunninen, 1938) Rankin, 1939 (Trematoda: Microphallidae) 13*
REARDON, LUCY V. AND CHARLES W. REES The cultivation of *Endamoeba histolytica* without serum 18*
REDMOND, W. B. Immunization of birds to malaria by vaccination 66*
REES, CHARLES W. The microisolation of *Endamoeba histolytica* and its cultivation with single species of bacteria 19*
REES, CHARLES W. (see Reardon and Rees) 18*
RENDTORFF, ROBERT C. Preliminary investigations on the life cycle of a cestode of the mouse, *Mus musculus* 38*
Review of the trematode superfamily Opisthorchioidea 5*
REZIN, PAUL F. (see McMullen, Rezin and Allison) 54*
Rhabdochona sp. (Nematoda: Thelaziidae), life cycle studies on 14*
Rhadinorhynchidae, a reconsideration of the family 8*
Rocky Mountain spotted fever vaccine, how it is prepared and used 27*
ROSE, HARRY M. (see Culbertson and Rose) 72*

Schistosomatium douthitti (Cort) in mouse, rat, muskrat, guinea pig and snow-shoe hare, experimental studies on 3*
Schistosome dermatitis: distribution and epidemiology in Michigan 54*

(* refers to abstract number rather than page)

Seasonal variation in emergence of cotylocercous cercariae 55*
Segmentation in the internal organs in infections with a Mexican strain of *Plasmodium relictum* 28*
Serological reactions of some helminths 75*
Sex ratio of *Trichinella spiralis* from the digestive tract of rats 52*
Siphonaptera: A study of the species infesting wild hares and rabbits of North America, north of Mexico 31*
Skin reactions, allergic, in human *Echinococcus* infection with antigens from related taenias 72*
SMITH, ALICE E. (see Leonard and Smith) 73*
SNYDER, THOMAS L. (see Meleney and Snyder) 41*
Sparganum mansonoides (Mueller, 1935), experimental human infection with 76*
Spelotrema nicolli (Trematoda: Microphallidae), life history of 59*
Spinitectus gracilis (Nematoda: Thelaziidae), life cycle studies on 14*
Spirorchis sp. (Trematoda: Spirorchidae), life history of 64*
Stichorchis subtriquetrus (Trematoda: Paramphistomidae), life history of .. 33*
Strigeid cercariae, two new species of, from Michigan 1*
Strigeid trematode from Douglas Lake, Michigan, life history of 65*
Strongyloides ratti, length of life of 70*
Strongyloides ratti, on the nature of age resistance to 71*
STUBBS, TRAWICK, H. (see Young, Coatney and Stubbs) 22*
STUNKARD, HORACE W. Life history studies and the development of parasitology 40*
Sulfapyridine, the effect of, on experimental avian coccidiosis 85*
SWANSON, LEONARD E. (see Harwood, Habermann and Swanson) 83*
Systems for designating hook pattern in Acanthocephala 7*

TALIAFERRO, LUCY GRAVES (see Taliaferro and Taliaferro) 67*
TALIAFERRO, W. H. AND LUCY GRAVES TALIAFERRO The protective action of immune serum against *Plasmodium lophurae* in chickens 67*
THOMAS, LYELL J. Further studies on the life cycle of a cestode from the herring gull 39*
THRELKELD, W. L. Progress report on pasture rotation and the prevalence of the helminth parasites of sheep in southwest Virginia 82*
Ticks (*Ornithodoros* spp.) in Arizona bat "caves" 24*
TIDD, WILBUR M. Studies on the life history of a parasitic copepod, *Lernaea carassii* 49*
Trichinella, effect of age of rat on size of infections of 51*
Trichinella, penetration of radioactive phosphorus into encysted larvae 80*
Trichinella spiralis, blood picture of white mice infected with 79*
Trichinella spiralis, recovery of larvae from early stages of infection 53*
Trichinella spiralis, sex ratio of, in digestive tract of rats 52*
Trichinella spiralis, transmission of immunity from parent to offspring 69*
Trichinosis, a practical plan for the control of 81*
Triganodistomum mutabile (Cort): Trematoda, life history of 61*

Ultraviolet microscopy, demonstration of 44*
Ultraviolet radiation, the effects of, on eggs of *Enterobius vermicularis* 43*

VAN CLEAVE, HARLEY J. Systems for designating hook pattern in Acanthocephala 7*
VAN CLEAVE, HARLEY J. AND DAVID R. LINCICOME A reconsideration of the acanthocephalan family Rhadinorhynchidae 8*
VAN DEN BERGHE, LOUIS *Glugea microspora*, a new microsporidian species from the liver of the sand-eel, *Amnodytes lanceolatus* 42*
Variation in a new cestode of the Genus *Raillietina* (*Skrjabinia*) from the prairie chicken 6*

VENARD, CARL E. The anatomy of the linguatulid, *Kiricephalus coarctatus* (Diesing) Sambon, 1910 ..... 46*

WALL, LIMAS D. Life history of *Spirorchis* sp. (Trematoda: Spirorchidae) 64*
WALLACE, HAROLD E. Life history of *Triganodistomum mutabile* (Cort): Trematoda 61*
WALLACE, HAROLD E. Development of the excretory system in *Cercariaeum mutabile* (Cort): Trematoda 62*
WENRICH, D. H. Some unusual variations in cystic stages of intestinal amoebae 20*
WILHELMI, RAYMOND W. Serological reactions of some helminths 75*
WOODHEAD, ARTHUR E. *Dioctophyme renale*, the giant kidney worm occurring in mink, from the southern counties of Michigan 50*

YOUNG, MARTIN D., G. ROBERT COATNEY AND TRAWICK H. STUBBS Studies on induced quartan malaria in negro paretics. II. The effect of reversal of the external conditions upon the infection 22*